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LIGHTING FROM CENTRAL STATIONS.

NOW that electric lighting from central stations is making some progress, a consideration of the means by which its future development may be effected may not be out of place. We believe we are correct in saying that the ideas of distribution on a simple parallel system which once prevailed have entirely disappeared, that no engineer would now think of distributing electricity from a central station at a pressure of 110 volts. In such a system the cost of mains would be prohibitive, nor are we sure that the three-wire system will gain many adherents, since though a saving of 62 per cent. is effected in the weight of copper the original outlay must still be very large.

In order that electrical energy may be distributed economically over even a small area the difference of potential at which the current is supplied from the generator must be greatly in excess of that required for each individual lamp, and the choice must lie between a single wire series system as advocated by the Bernstein Company, and a transformer system as worked in London by Sir Coutts Lindsay & Co. In the first method one conductor runs from lamp to lamp round all the circuit fed from one generator, the lamps being of low resistance and taking about 7 volts each. The current is 10 ampères and the maximum number of lights on one machine is 350, this corresponding with a total potential difference of 2,500 volts. Mr. Bernstein has devoted to the perfecting of this system a considerable amount of energy and ability, but when perfect its application must be but limited. Here the number of lamps on a circuit is determined by the difference of potential at which it is considered safe to run at the generator, and only a single circuit can be obtained from each since the difference of potential is proportional to the lamps alight. The element of uncertainty which the system at first possessed has doubtless been largely reduced by the introduction of a safety plug which short circuits each lamp, as in its last hours its resistance increases, but still there is some uncertainty from the fact that the supply of all the consumers depends on one conductor, and we are thus compelled notwithstanding the ingenuity displayed in working out many of the details to declare in favour of transformers.

Transformers may be divided into two classes, accordingly as they are designed for working on alternating or continuous current circuits. The construction of the former class of apparatus is well known, all the different forms being in design mere modifications of an induction coil in which the magnetic circuit is of the lowest possible resistance. The primary circuits of the various transformers being fed in paralled by an alternating current of high potential, a current of low potential is generated in the secondary circuits in which the lamps are connected also in parallel. This system is at work in England, on the Continent, and in America, but transformers belonging to the second or continuous current class are of comparatively recent date. The best known are in some form or other a combination of electro-motor and dynamo, the motor part being actuated by a high potential current and analogous to the primary circuit in the first class of apparatus, the dynamo part yielding a current of low potential which may be employed for lighting or any other purpose for which an electric current is employed.

We have in this journal advocated from time to time the use of storage batteries in central station lighting, believing that, though the cost of the plant is thereby greatly increased, the immunity from risk of breakdown would amply compensate for the increased cost. We quite agree with those who say that by high-class management and well-directed arrangement a serious breakdown can be rendered highly improbable, but there is all the difference in the world between improbability and impossibility. The latter attainment is the one to be striven after, and we imagine we get nearer to it when secondary batteries are employed than when they are not. That we are not quite alone in this opinion is shown by the manifesto recently issued on the subject by the Edison Company of America.

Apart from the fact that distribution of power by alternating currents is at present out of the question, it has always seemed to us that in the impossibility of employing secondary batteries as reserve power against emergencies lies the weakness of the alternating current system for central station lighting. It is for this reason that we should prefer the continuous current system, if the transformers prove as little troublesome in the matter of requiring attention as we imagine they will. Certainly the continuous current transformer is not so simple as the alternating current one. It has a rotating armature wound with two coils, it has two collectors and two sets of brushes, it has a lubricator to fill with oil occasionally, all, it must be acknowledged, disadvantages as compared with the induction coil apparatus. But as a set-off against these disadvantages there remains the fact that it can be employed to charge a secondary battery situate in the cellar, and if anything goes wrong at the generating station, or anything happens to the transformer, the consumer is not by the occurrence placed in darkness.

The necessity for a secondary battery at the central station is obviated by the continuous current transformer, for each consumer can have a battery at his option. If he wants to ensure himself against the inconvenience of an occasional breakdown, let him charge a battery from his transformer, if he had rather take the risk he can dispense with the battery. The attention required by the apparatus need be very small. No work is being done save that due to the spinning of the armature round and the overcoming of magnetic and mechanical friction. The brushes need not spark, and probably would not

require attention for months. Nor is this all. The transformer being merely a high potential electro-motor, with an additional dynamo-acting coil on its armature, can be employed for furnishing power only, or light and power at the same time, in any desired proportion up to its full capacity; a fact which will not be neglected by those who look forward to supplying from their generating plant power during the day as well as light at night. That the new method of distribution has many disciples we doubt not, and that it will prove a powerful rival to the alternating current system is almost a certainty.

In Britain, Paris & Scott; in America, Edison; and on the Continent, Jehl & Rapp, are hard at work on transformers of the continuous current type. We are anxious to see the system tried, but, above all things, let the inventors be certain on every point before submitting it for public criticism. We recollect only too well the disasters accompanying the introduction of the alternating transformers, and we should regret bitterly a repetition of history in connection with a more recent system which contains, we believe, the germ of success.

THE article which we publish on another page, descriptive of the application of electricity to mining purposes, will be read with interest. There is a vast field for pumping operations, transmission of power over long distances, and electrical haulage in mines, and electrical engineers will look forward to the further developments which Messrs. Immisch are about to make. We cannot too strongly recommend that the attention of mining engineers should be drawn to these experiments.

THE Liepmann battery, concerning which we hope to give some data shortly, impresses us greatly with its cleanliness and absence of noxious fumes. The creeping of salts, which forms so objectionable a feature in many of the best known forms of primary battery, is conspicuous by its absence, and the method of making metallic contact with the carbon electrode is also deserving of special commendation. Inquirers may do worse than make a point of examining into the merits of the Liepmann batteries, the proprietors of which do not lay claim to anything opposed to well-known facts.

ST. JAMES'S HALL is, we understand, electrically lighted from the Grosvenor Gallery station. Now, it is most important that a concert hall should be well illumined, and for many reasons there should be no fear of any hitch, yet we hear of frequent failures in the system employed at St. James's. A private consumer has only himself to blame if he decides upon the employment of a particular light which every now and again plays him false, but those who cater for the public should be careful in their selection. Music-loving people do not care to be annoyed by the sudden extinction of a group of lamps, and its too frequent occurrence can only have one result, and that not beneficial to the proprietors.

USERS of arc lamps will be gratified to learn that an English firm will shortly be in a position to supply cheap carbons on terms which will compare favourably with the prices of those now imported from America.

TECHNICAL education is a subject which deserves and requires constantly to be brought before the public, and during the past week or so several of the leading statesmen have devoted attention to it in their speeches. In addition to this Prof. Silvanus Thompson, enthusiastic and energetic upon this topic as upon many others, has held a conference at Finsbury, to which working men were invited, to discuss the question. He addressed the gathering upon "The Present Position of the Technical Instruction Question," and then invited comments. The invitation met with ready response, many valuable suggestions and opinions being elicited, and different sides of the subject being presented by the various speakers. Greater national expenditure upon education was advocated, likewise a well organised system of apprenticeship which should ensure good technical training to the apprentices, whilst a Mr. Ayton, a carpenter, was in favour of the limitation of the number of learners of each trade. This last suggestion is scarcely likely to meet with much support from those who consider the question in all its bearings, but it has a certain attractiveness which commends it to the working man struggling against the conditions brought about by the superabundance of supply in excess of demand. Prof. Thompson's paper dealt largely with the work of the institutions of the City and Guilds of London. Discussing the question of the best form to give to the national organisation of technical instruction, he presented the claims to the honour of directing the future organisation of the City and Guilds Institute, the National Society for the Promotion of Technical Education, and the Department of Science and Art at South Kensington. South Kensington methods are not the methods of Prof. Thompson, and he exulted that the bid for the future management of technical instruction made by the Department by the introduction of the abandoned Technical Instruction Bill resulted in failure. What is wanted, according to Dr. Thompson, is a real Educational Department under a real, responsible Minister of Education.

THE adherents of electric traction will find much in the paper of Mr. Wharton to encourage them. It is becoming more and more apparent that electricity will take the place of horses for tramway purposes throughout the greater part of the United States, and it is purely a question of time for the laggards in this country to emulate the example of our American cousins.

MESSRS. CHAMBERLAIN AND HOOKHAM are to be congratulated on the result, so far achieved, of their electric lighting enterprise in Leamington. Full particulars of this, the largest installation of town lighting in the kingdom, can be seen in our other pages, and we hope that the scheme formulated in this well-known Midland town may speedily be followed by others of a still more extensive nature. It is only when carried out on a scale like this that the advantages of electricity over gas or other methods of lighting can be clearly demonstrated.

A LETTER appeared last week in our estimable contemporary *Industries* on the subject of the projected new Electrical Association. The writer commented upon the stand taken in the matter by several technical journals, but the tone adopted leads one to the belief that he had been building hopes, which may perchance be blighted, of eventually figuring in the Association in some official capacity. We believe that if we placed our hand upon the shoulder of him we suspect as being the author of the letter above mentioned and said unto him "thou art the man," he would turn out to be one of the "unemployed."

ELECTROLYSIS OF COBALT SALTS.

By ALEXANDER WATT.

IT seems somewhat remarkable that so interesting a metal as cobalt should have received so little attention at the hands of the experimentalist. This may, however, be in some measure due—as was the case with nickel at one time—to the difficulty of obtaining cast or rolled plates of the metal to serve as anodes, without which experimental operations could not be performed with ease and exactitude. Now that this difficulty has been overcome, and cobalt anodes, either in cast or rolled metal, are readily procurable as ordinary commercial products, not only may we experiment with ease, but the electro-deposition of cobalt upon other metallic surfaces, for the various purposes of the arts, is rendered practically possible, and will doubtless receive more general attention when its advantages become better known. In referring to electrolytic cobalt, it is almost the invariable rule to compare it with its mineralogical associate, nickel, and in these comparisons we find much diversity of opinion: for example, Becquerel states that cobalt deposited from a solution of its chloride, "has a brilliant white colour, like that of iron;" Gaiffe says that when deposited from the double sulphate of cobalt and ammonium, it is "superior to nickel, both in hardness, tenacity and beauty of colour;" while, according to Stolba, "salts of cobalt, treated in a similar manner to those of nickel, yield a metallic deposit of a steel-grey colour, less lustrous than nickel, and more liable to tarnish." These divergences of opinion, and many others equally at variance with each other, irresistibly recall the celebrated fable of the chameleon, and incline me to say, with the philosophic creature in the fable, "you all are right, and all are wrong," and for the following reasons: in the first place, the whiteness of electro-deposited cobalt depends greatly upon the nature of the electrolyte employed; again, the density of the current influences the colour of the deposit considerably, as is the case with most, or, perhaps, all other metals; the strength of the solution also greatly affects the colour of the deposit, and so likewise does the amount of anode surface immersed in proportion to that of the receiving plate. Referring to the deposit from a solution of the chloride of cobalt, neutralised with ammonia or caustic potash, Becquerel says that the deposited metal is "brilliantly white, hard and *brittle*," whereas most persons agree that electro-deposited cobalt is exceedingly tenacious; to which latter view I must humbly add my own testimony, for I have found that from well-prepared solutions of cobalt, with a rather feeble current, the deposited metal has adhered to copper, brass and steel with remarkable tenacity, the first film of cobalt alloying itself with copper in a very marked degree. As to the comparative hardness of cobalt and nickel, I am unable to agree with M. Gaiffe that cobalt is inferior to nickel in this respect, for I have invariably found that while cobalt admits of being burnished without difficulty with a steel burnisher, nickel yields but little to the influence of the tool. Respecting the magnetic properties of electrolytic cobalt, I lately removed the deposit of this metal from a slightly greased plate—which readily peeled off in bright laminæ—and on testing these with a small magnet observed that they were perceptibly influenced at the distance of 2 inches apart; and when the magnet was held about an inch from the stripped metal it was at once attracted to the instrument; the laminated metal was then placed in a small glass bottle, and the magnet allowed to touch it, when the scales of cobalt immediately rose to the interior surface of the bottle nearest the poles of the magnet. One piece of the metal was then made red hot, but this in no degree diminished its magnetic property; indeed, when the still red hot metal was presented to the magnet it was at once attracted to it, being absolutely uninfluenced by the heat. I believe it was Faraday's opinion that pure cobalt is not magnetic; possibly the great philosopher's conclusion was founded upon experiments performed with cobalt reduced by fusion, which possibly may differ in its molecular condition from cobalt reduced by electrolysis. If we may assume that electrolytic cobalt, obtained from solutions of carefully-prepared cobalt salts, is almost absolutely pure—in which no trace of nickel or iron is present—then it would appear, from the results which I have obtained, that pure cobalt, reduced by electrolysis, is not only magnetic, but is so in a very high degree. Having obtained deposits of this metal from solutions of a great number of different salts, I can confidently state that in each case the cobalt was readily affected by the magnet, and in some degree retained this property.

One other point, in connection with the electrolysis of cobalt salts, I must here refer to, namely, that nearly all those who have devised formulæ for cobalt baths for electro-deposition, prefer to employ solutions which are either neutral, or more or less alkaline, but, so far as I am aware, in no case acid. Although the neutral or alkaline condition of the bath, in the case of some solutions, is undoubtedly an advantage—if not, indeed, an actual necessity—I have found that certain solutions, to which I will direct attention shortly, were greatly improved when put in a faintly acid condition. Indeed, in some instances, when the deposit after a time assumed a dull appearance in an alkaline bath, the entire condition was changed to a perfectly bright deposit when the bath was rendered *positively acid*. In working solutions which are more or less acid, however, some little extra care is necessary to prevent the film from stripping or peeling off the receiving surface; the deposit must be allowed to commence slowly, with small anode surface in the liquid, and as the coating thickens, the anode surface may be gradually, but moderately, increased. In no case should a current of high tension be employed; the E.M.F. of two Daniells in series will reduce cobalt in a good reguline condition from almost any of its solutions, and with some a single cell will produce a similar result. In pursuing my experiments with solutions of cobalt salts, I employed a series of Daniell cells, of the capacity of about one quart each, with amalgamated zinc bars, in a solution of sulphuric acid, composed of one part acid to about 20 parts of water. The anode consisted of a plate of rolled cobalt of very good quality, and the solutions in each case were electrolysed at the ordinary temperature.

1. *Acetate of Cobalt.*—A quantity of carbonate of cobalt was first prepared, by precipitating the metal from a solution of sulphate of cobalt with a solution of carbonate of soda (soda crystals). The precipitate was then drained upon a filter and repeatedly washed with hot water. In this and the following experiments the carbonate of cobalt was used in its moist, but well drained condition. To form the acetate, two ounces of commercial acetic acid were taken, and freshly the precipitated carbonate of cobalt added from time to time, with constant stirring, until the acid was nearly saturated, when smaller additions of the carbonate were given, and the solution well stirred until it was all dissolved before adding more. When the resulting solution reached a point at which there was but a slight trace of free acid, it was determined to ascertain its behaviour under the current in this faintly acid condition; before doing which, however, it was diluted with water to make up a half-a-pint bath. Two Daniells having been connected in series, and the anode placed in the liquid, a strip of sheet copper, one inch wide and three inches long, having a copper wire soldered to it, was immersed in the bath to the extent of about two inches, and this promptly received a brilliantly white film of cobalt. After about a minute the plate was removed, and was then scoured with fine sand and a little water, to test its tenacity, when it was found to resist this harsh treatment well; it was then dipped in dilute sulphuric acid to dissolve the film, and when this was removed the copper exhibited a rough surface, indicating that the cobalt had to some extent alloyed itself with the copper surface. The plate was next re-scoured and returned to the bath to

receive a more substantial coating. On examining the plate, after about a quarter of an hour's immersion, it was found that an exceedingly bright and purely white coating had been deposited, and the plate was again returned to the bath to receive a further deposit. In watching the rate of deposition when the newly prepared plate was first immersed in the bath it was found that the deposit took place with sufficient speed when the surfaces of the electrodes were about equal; if there was a slight preponderance it was in favour of the cathode. It may here be remarked that in this respect, as in many others, cobalt differs greatly from nickel, which invariably requires a large anode surface to obtain a deposit at all.* After the copper plate had received a fair coating of cobalt, which was found to be very adherent, the burnisher was applied, which brightened the surface without much labour, the metal, in fact, feeling agreeably soft under the pressure of the tool. By simple immersion, a strip of sheet zinc became coated with cobalt in this solution. A strip of copper, in contact with another of zinc, also received a film of cobalt in the same solution.

2. *Ammonio-Acetate of Cobalt.*—A solution of acetate of cobalt was first prepared as before described, but the points of saturation of the acetic acid with the carbonate of cobalt was not carried quite so far, it being intended to neutralise the liquid with ammonia, which was done while the solution was in its concentrated state, by adding a solution of ammonia (about equal parts liquid ammonia and water) until the liquid was neutral to litmus paper. The strong solution was now made up to half-a-pint with cold water, and was ready for use. A copper plate was then connected to the negative electrode and immersed in the bath, when, after a few seconds, a white film appeared on the surface; the plate was then allowed to rest in the bath for about two minutes and was then examined, when it was found that the coating had assumed a dull and brownish colour; a drop or two of ammonia was then added to render the bath alkaline, and another plate immersed, which in a short time assumed the same unfavourable aspect. From one to five Daniells were tried consecutively, but there was no obtaining a bright coating. It was then determined to add acetic acid, a few drops at a time, until the bath yielded a more favourable deposit, and after each addition of the acid a fresh plate was tried, the film on which exhibited a gradual change for the better. It was not, however, until the solution had been rendered strongly acid that it would yield a coating of really good quality, and when this point was reached the deposit was exceedingly brilliant, white, and reguline, which character it retained for about two hours, when the plate was withdrawn from the bath.

3. *Citrate of Cobalt.*—A solution of this salt was prepared by digesting recently precipitated carbonate of cobalt in a solution of citric acid, 120 grains of the powdered acid being dissolved in two ounces of water. The acid solution rapidly dissolved the carbonate, forming a claret-coloured liquid. When the acid solution approached saturation, it was diluted with cold water to make up a half-pint bath, and was then tried in this faintly acid condition. With a current from two Daniells, a copper plate received a bright and perfectly white deposit almost instantaneously. After a short time the deposit became dull, when a little more citric acid was added, with advantage, for the film at once became brighter. The deposits from this solution on copper, brass and steel were very adherent, but the colour of the film, by comparison with the latter metal, had a slightly yellow tinge. There was very little evolution of gas at the cathode, and the anode dissolved freely, the immersed surface remaining clean, with the exception of a slight, grey, insoluble powder which rested on the surface.

4. *Ammonio-citrate of Cobalt.*—A solution of citrate of cobalt was first prepared, as above, by dissolving carbonate of cobalt in a moderately strong solution of citric acid, the latter being allowed to remain in slight excess. The liquid was then neutralised with ammonia (equal parts liquid ammonia and water), and water added to make up half-a-pint of solution. The solution was first tried in its neutral state, when a white deposit of metallic cobalt gradually formed on a copper plate; in a few seconds, however, the film became dull, and of a dark colour: 10 grains of citric were now added to the bath and a freshly-prepared plate tried. The deposition was now more active, the film of a better colour and much brighter; to secure a bright deposit, however, it was found necessary to add more citric acid, therefore another 10 grains were added, which at once put the bath in good working order. It was now resolved to leave a plate in the bath for a long period in order to ascertain whether the anode became dissolved with sufficient rapidity to keep up the strength of the bath: after twelve hours' action the bath remained in its normal condition, the anode having been freely dissolved. There was, however, a thickish coating of grey insoluble matter on the anode, which, when wiped off with the finger, exposed a perfectly clean surface of cobalt. The deposit upon the cathode, which was of considerable thickness, was of a dark grey colour and nodular, and only fairly reguline at the upper portion of the plate. The solution was afterwards tried with a smaller anode surface, when better results were obtained; this electrolyte, however, does not appear so suitable for electro-deposition as the single salt of cobalt.

5. *Sulphate of Cobalt.*—For this and the following experiment the cobalt salts manufactured by Messrs. Henry Wiggin & Co., of Birmingham, were employed, and as commercial products are deserving of high commendation. To prepare a small bath from the single sulphate of cobalt, 150 grains of the crystals were dissolved in half a pint of water, the proportions being at the rate of 5 ounces of the cobalt salt per gallon. From one to five Daniells were tried with this solution, but the current from two cells in series was found to give the best results; with this current a prompt deposit of cobalt, of a brilliant white colour, was obtained upon a copper plate, the film sustaining its brightness for a long period; the coating was, moreover, exceedingly uniform in character. After several hours the surface of the plate felt somewhat rough to the touch, due to the formation of minute crystals on the surface, which was doubtless owing to the electrodes having been too close to each other, which sometimes happens when small quantities of liquid are operated upon; this solution, however, if worked on a large scale, should give very good results, provided that too large an anode surface is avoided. In depositing from cobalt solutions for practical purposes, it is necessary that the work to be cobalted, if to be finished bright, should be thoroughly well polished, and all scratches obliterated, as for nickel plating, otherwise such blemishes will appear, in all their hideousness, in the finished work.

6. *Double Sulphate of Cobalt and Ammonium.*—To prepare a bath from these salts, 150 grains of the crystals were dissolved in half a pint of water. Two Daniells were employed, in series, as before, and plates of copper, steel and brass, respectively, used as the cathodes. A copper plate was first tried, and this became coated with a bright film of cobalt immediately after immersion, when the anode was partially raised out of the solution, to enable the deposit to proceed more slowly. On examining the film, after a few seconds' immersion, and well scrubbing it with moistened silver sand, the deposit was found to be perfectly adherent, a portion of the metal having alloyed itself with the copper. On returning the plate to the bath, and allowing it to remain therein for about half an hour, the film assumed a somewhat dull character, but this was readily brightened with the scratch-brush, or even by gentle scouring with silver sand, neither of which treatments would much have affected a deposit of nickel—another proof that electrolytic cobalt is softer than the former metal. A steel plate was next placed in the bath, when, with the current from a single Daniell cell, this became

* Except when chloride of sodium is added to the bath, which greatly increases the conductivity of nickel solutions.

quickly coated with cobalt, of good colour, and very firmly adherent. As a practical depositing solution, that of the double sulphates of cobalt and ammonium may be reckoned as one of the best. When we find, however, that the current from a single Daniell cell is quite sufficiently strong to deposit this metal in its best condition, and quick enough for all practical purposes, much care must be taken to avoid too strong a current when dealing with this solution on a practical scale. With this precaution, and avoiding an excess of anode surface, the solution has much to recommend it, and there is little probability of its getting out of order, except from accidental causes. Although cobalt salts and anodes are much higher in price than the corresponding nickel products, the public will probably "take to" cobalt plating when good samples are placed before them, if only on account of novelty. The superior whiteness of the deposited metal, as compared with nickel, however, will tell most in its favour.

7. *Borate of Cobalt.*—A solution of this salt was formed by dissolving freshly precipitated carbonate of cobalt in a hot and strong solution of boracic acid, the resulting liquid having a slightly pink tint. This acid, which is sparingly soluble in water, dissolves only a small portion of the carbonate, but sufficient, however, to make a tolerably good electrolyte for an experimental purpose. The solution was used in its most concentrated form, with the current from two Daniells, when a very bright and white film of cobalt became deposited upon a clean copper plate immediately after immersion. There was a good quantity of hydrogen liberated at the cathode, and the coating eventually became rather dull. A single cell was then tried, and a fresh plate immersed, when the deposit was more gradual and the colour of the metallic film greatly improved, and continued to keep bright for a long time. There was scarcely any hydrogen liberated when the single cell was used.

8. *Tartrate of Cobalt.*—To form a bath from this salt, a hot solution of tartaric acid was first prepared by dissolving 120 grains of the acid in two ounces of hot water. A quantity of moist carbonate of cobalt was then added gradually, with constant stirring after each addition, until the solution was saturated; water was next added to make half-a-pint of solution and the bath was ready for use. With the current of one cell the deposition was rather slow, but a white metallic film was obtained in about a quarter of a minute; after the plate had been in the bath about ten minutes, the film became nearly black in parts, but having a white film beneath; a few grains of tartaric acid were now added and a fresh plate immersed, when the deposition progressed more favourably and a fine white and bright coating of cobalt was obtained; with the single cell, however, it was found necessary to immerse a much larger surface of anode. Two cells were next tried with smaller anode surfaces and a freshly prepared plate put into the bath, which promptly became coated with cobalt of a good white colour, the deposition taking place at about the proper rate to yield a favourable layer of the metal. During the electrolysis the anode kept perfectly clean and bright, excepting that the powdery film before noticed again appeared on the surface. It may be mentioned that this insoluble matter, which I have not yet examined, was always present, more or less, on the anode in all cases, and may, therefore, be due to some impurity of the cobalt of which the anode was made, or, possibly, it may be a suboxide, insoluble in the weaker acids.

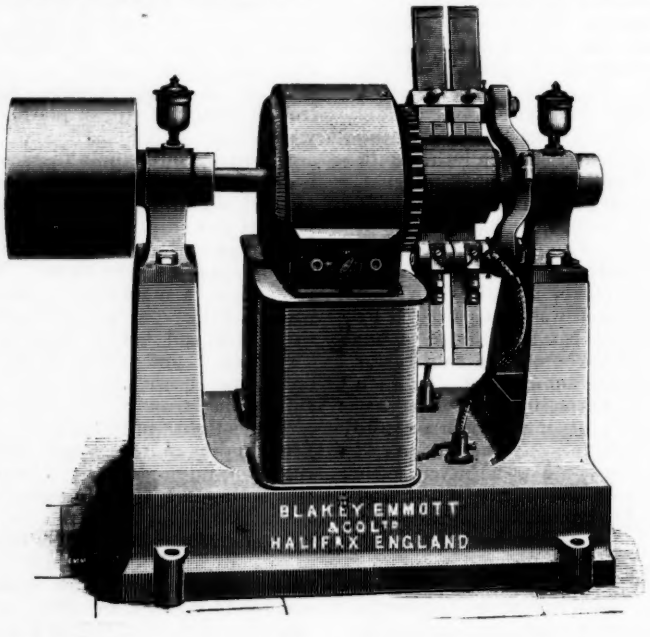
(*To be continued.*)

ELECTRIC LIGHTING ON THE STEAM YACHT "THETIS."

THIS handsome yacht, which has just been built for Mr. John Donaldson, of Chiswick, has been fitted with a very complete installation of electric light by Messrs. Muir, Mavor and Coulson, of Glasgow. About 100 lights are fitted throughout the ship, electric lamps being used in the masthead and side signal lamps and in the anchor lamps. The fittings in the saloon, deck houses and cabins are of a very handsome type, and the globes, which are egg shaped, are about two-thirds obscured, but the upper third being clear allows the light to strike directly on the white ceilings, which reflect the light, adding considerably to the effect. Portable hand lamps are provided in each of the six large store and baggage rooms in the hold, at the steam steering gear, and in the engine room for examining the accumulators and for the bilges, &c. There is also a gangway lamp enclosing 3 50-C.P. lamps, which may be suspended from a small special davit on either side of the navigating bridge, a strong diffused light is thus thrown along the ship's side, which is a great convenience for boats leaving or coming alongside. Another beautiful addition to the installation is a projector. Pedestals to which the cables are brought are fixed on either side of the bridge, and the cylinder containing the lamp and mirror may be mounted on either side as required (when not in use it is secured on the centre line of the ship). To extend the range of usefulness of this interesting adjunct a dispersing lense may be fixed to the front of the projector: this disperses the rays in a horizontal direction, giving a flat beam when it is desired to light a large area of quay side or beach for the use of small boats when embarking passengers, water, or provisions. The wiring of the ship is divided into five circuits controlled from the upper platform of the engine room, where the switchboard and measuring instruments are fixed. Double pole fuses are fixed on the switchboard for each circuit, and from these fuses the cables are led directly to five distributing boxes in various parts of the ship. All the branch wires converge from the lamps to these boxes and are connected to the cables through double pole fuses. The distributing box for the lamps in machinery space is fixed in the engine room and is of cast brass, perfectly water-tight; all wires in engine and boiler rooms are sheathed with lead. The fuses and switches throughout are mounted on slate bases, and the cables are encased in substantial teak wood casings. In each case where a water-tight bulk-head is pierced the wires are brought up to the upper deck and down again as required, no holes being allowed in bulk-heads below the main deck. An accumulator with a capacity of 600 ampère-hours is fixed in the engine room beside the generating plant. The boxes, which are of metal alloy, are arranged in three tiers up the ship's side. They are set upon glass insulators, and each cell is separately secured in place by a system of levers and screws completely insulated by glass insulators. The generating plant consists of a Willans central valve compound engine coupled direct to a Siemens dynamo, which is wound to give 120 ampères at 65 volts as a simple shunt, and at 50 volts as a compound machine at a speed of 400 revs. per minute. The engine is fitted with a Willans governor, a sight feed lubricator and tachometer. A somewhat unusual feature of the installation is a complete auxiliary condensing apparatus; this has been designed and manufactured by Messrs. Thornycroft. It consists (in addition to the copper condenser and hot well) of a small double-acting vertical engine running at 400 revolutions per minute, driving through worm gearing a shaft to which are coupled, by cranks, the circulating air and feed pumps. A three-way cock is fitted in the Willans engine exhaust pipe, so that the exhaust may be directed into the main condenser, the auxiliary condenser, or the atmosphere. The feed water from the auxiliary condenser may be delivered to the main or to the auxiliary boiler. The complete plant, consisting of the dynamo and Willans engine, the condenser and the circulating gear and the storage batteries, is arranged on the starboard side of the engine room between the starting platform and the ship's side, but does not in the least encroach on the space required on the platform, while every part is easily accessible. The arrangements appear admirably adapted to the ship, and no trouble has been spared to make this one of the most perfect installations afloat.

THE "BLAKEY-EMMOTT" DYNAMO.

WE illustrate this week a new pattern dynamo made by Messrs. Blakey, Emmott & Co., Limited, of the Northern Telegraph Works, Halifax. It is of the single magnet type, with the poles at the top. The whole magnet is in one U-shaped forging, thus avoiding in the magnetic circuit both the resistance of joints and the use of cast iron. The armature is of the modified Gramme type, and is built up of thin insulated discs of annealed iron; the whole being securely mounted on a gun metal spider, which is keyed to the shaft, thus ensuring positive mechanical driving. The armature is wound with only one layer of wire. The commutator consists of 40 sections of specially hard drawn copper insulated with mica. There are two brushes on each side, each separately adjustable, and fitted with hold-off catch. The shaft is of steel; the bearings are of best gun metal, and are of ample length. Sight-feed lubricators are used, by means of which the quantity of oil delivered can be readily seen and adjusted. The pulley is wide, thus favouring steady driving. The whole machine is put together on a strong cast iron base, which makes a very rigid foundation. The machine under notice,



which is compound wound for constant potential, is intended for an output of 60 ampères and 100 volts, the speed being 1,100 revolutions per minute. The cross sectional area of the magnet bars is 30 square inches. The total cross sectional area of actual iron in the armature is 20 square inches. The total excitation of field magnets at full load is 12,130 ampère turns. The total strength of useful field is 378 lines (English measure). The density in the magnet cores is 12·6 lines per square inch, and in the armature core 18·9 lines per square inch. The length of wire on the armature is 360 feet, which is at the rate of 43·2 inches per volt, or at a periphral speed of 3,000 feet per minute, at the rate of 37·3 inches per volt. The total weight of copper in machine is 95 lbs., and in the armature alone 13 lbs. This gives an output of 63 watts per lb. of copper in the whole machine, and 461 watts per lb. of copper in the armature only. The electrical efficiency at full load is over 92 per cent. The machine keeps cool after long runs, and there is a total absence of sparking at the brushes. This type of machine is now being constructed by Messrs. Blakey, Emmott & Co., Limited, in different sizes, intended for outputs varying from 10 to 1,000 lamps. We may add that the machines are mechanically well finished, and the electrical efficiency of the larger machines is still higher—an 18-unit machine giving over 95 per cent. electrical efficiency.

ELECTRIC LIGHTING OF THE PARIS HIPPODROME.

THIS large building was first illuminated by the electric light in 1877, and since that date large additions have from time to time been made to the number of lights, and lately great improvements in the service have been made by the engineer, M. Ernest Berthier. The installation is now composed of :—

	Candles.
153 Jablochkoff candles, 4 mm. (22 carcels), equal to about	23,408
18 Gramme regulators, Type 1 (500 carcels), equal to about	72,000
1,083 incandescence lamps (1 carcel), equal to about	8,680
Total candle-power, about ...	104,088

The machines employed are :—

	Revs. per min.
24 Gramme machines, ordinary type, driven at about	1,000
7 Gramme machines, for alternating currents, driven at about	850
2 Edison machines, of 110 volts and 150 amps., driven at about	1,260

Two compound condensing engines, of 100 horse-power each, are used for driving the machines.

The cables are composed of seven wires of 0·009 m. each.

The actual working expenses of the electric lighting per evening (3½ hours) is calculated at :—

Jablochkoff candles	38·20	francs.
Levy carbons	5·25	„
Swan lamps	8·75	„
Coal	42·70	„
Greasing	19·40	„
Various items	13·50	„
Water	10·70	„
Staff	87·85	„
	227·35	francs.

In addition to this amount there is to be added on the cost of gas, which, to a certain extent, is still employed :—

Gas consumption	93·0	francs.
Oil lighting...	3·75	„
Staff	7·15	„
	103·90	francs.

or a total expense per evening of 331·25 francs.

Were the building completely illuminated by gas the expenses per evening would, it is estimated, amount to 1,873 francs, calculating the consumption per hour at 1,784 cubic metres at 0·30 francs per cubic metre.

MANUFACTURE OF CARBONS.

TO obtain good carbons is a desideratum both in connection with arc lighting and for primary battery and electrolytic purposes. With respect to the former, it is hopeless with many of the lamps commonly in use to get them to burn with anything like satisfactory steadiness except with good rods, and it has therefore been the aim of makers in this country to produce for this purpose a good carbon rather than a cheap one. In this direction, probably, no firm has met with greater success than the Liepmann Carbon Company which produces a carbon of the most homogeneous and even kind, free from impurity. This has only been accomplished by considerable perseverance, and the invention of special processes and machinery, which at the invitation of the managing director of the company were inspected a few days ago by a number of gentlemen interested in the subject.

The raw material with which the manufacture starts is a specially selected crude carbon which when broken up into small lumps is rough like ordinary coke, but has a very shiny appearance. These small lumps are fed into a machine, which working at a speed of 2,600 revolutions a minute, reduces them to an impalpable powder. This powder is collected from the grinder and put into mixing mills where it is worked up with certain ingredients into a plastic mass which passes on into the pressing machines, worked from an hydraulic accumulator 50 tons in weight which enables the moulding of the carbons into the shape of solid or cored rods and battery plates to be effected at a pressure of 5½ tons on the square inch. In passing from the moulding machines, the carbon rods or plates are automatically cut to any required length and are then ready for drying. This is the most tedious portion of the manufacture, as it is of importance that the drying should be effected gradually. Ultimately the carbons are packed in iron boxes and run on trams into the furnaces, of which there are eight. These are heated with gas kept at a constant steady pressure which can be easily varied as required by means of valves, no fire or flame being visible except through the "peep holes" provided for the purpose. By the aid of an ingenious electrical recorder the temperature of these kilns during the night can be read off every morning. After baking, the resistance of every carbon is tested singly by a device specially designed for this purpose at the side of a revolving drum over which the rods are fed, the result of the electrical arrangement being that the carbons with a sufficiently low resistance are automatically passed and the bad ones are rejected. Finally they are taken to an emery wheel to be finished off and pointed. In another department of the works are tanks in which rods can be copper-plated, the plan adopted being somewhat different to that usually pursued. In the store and packing rooms an immense numbers of rods and plates are kept ready for delivery, the length of time required for the drying processes rendering it necessary that a large stock should be allowed to accumulate ready for immediate delivery. Throughout the works every possible kind of labour saving appliance has been adopted, and the machinery is the best that could be devised for the purpose. The plates and rods produced at these works are believed to be unsurpassed for battery and metallurgical purposes, as they are free from both disintegration and creeping. This has been proved by tests extending over a period of two years. The company turns out a large number of Leclanché cells, which it is contended, while as good as any in other respects, in the matter of insulation are far better.

Having succeeded in producing a perfect carbon as to quality, the question has now arisen, why should not the company be able to produce a cheap carbon? It is a remarkable fact that though America is at a disadvantage (which has been estimated at 30 per cent.) as compared with this country in the matters of wages, cost of machinery, price of coal, and other matters, yet a very large proportion of the carbons burnt here are of American manufacture. The Liepmann Company believes that by putting down extra plant and adopting the American system of manufacture the common quality of carbons can be produced at a cheaper rate than that at which they are now imported, and steps are being taken for multiplying the present facilities, so that instead of turning out one million carbons a year it will be easy to produce five millions.

The aim amongst manufacturers now being to produce an arc lamp or an arc lighting system which shall be competent to give a good steady light even with cheap inferior carbons, there can be no doubt that the demand in the future will be more for a low-priced low quality article than for one that is perfect at a higher price.

An important branch of the business of the Liepmann Carbon Company is the manufacture of the Liepmann battery, of which probably more will be heard in the future than of some others about which so much trumpeting has been going on recently. In conclusion we may add that the Liepmann Carbon Company bids fair to become a very important factor in the electrical industries of the future. Our thanks are due both to Dr. Liepmann and to Mr. Mayer, the manager, for so ungrudgingly placing their time at our disposal during our inspection of their works.

NOTES FROM SCANDINAVIA.

IN Copenhagen the telephone is becoming more and more extended, though its use in that city is far from being so general as in Stockholm. Copenhagen is now, however, in telephonic communication with several of the principal cities around on the island of Zeeland. The annual subscription in the capital is £8 10s. and in the suburbs £9, but a reduction will shortly take place. However, by the more extended use of the telephone a considerable reduction has naturally taken place in the number of telegrams and letters despatched.

The town of Filipstad, in Sweden, has been wholly lighted by the electric light since October 1st, to the entire satisfaction of all concerned. The glow lamps are of 16 candle-power each, and are fixed on poles along the streets at an interval of 150 feet, the light being thus only slightly stronger than that of gas lamps generally used for this purpose, that strength having been found the most suitable. On an island in the river running through the town a lamp of 2,000 candle-power has been fixed on a lofty pole, which lights the market place and the park. Most of the shops and factories in the town, as well as many private houses, are also now lighted by electricity, and in some of the former the light can, when they are closed, be turned on to the dwelling portion of the house, whereby a saving is effected. The lighting of the city is effected by the Filipstad Electric Company, which has secured a splendid site for its plant in the centre of the town. The motive power for the dynamos is water obtained from the river referred to, whereby, of course, the cost of the light is greatly reduced.

In the town of Skelleftea, too, in the north of Sweden, arrangements are being made for lighting the streets by electricity.

Of course it should be born in mind that in a country like Sweden, where the motive power is so cheap, it may be expected that the electric light will in a few years supersede gas, particularly for street lighting and business purposes.

The great new hall in the building just erected by the Stockholm General Telephone Company, of which we gave a detailed description a few months ago, was opened for the use of the public last month, and the number of persons making use of the same has reached as much as 8,000 a day. The whole of the company's new plant has been found to work with the greatest regularity, and general satisfaction is expressed with all arrangements.

From the report just issued of the working of the

telegraphs of Norway during the first seven months of the year it appears that during this period 264,293 messages were transmitted inland, 97,352 abroad, whilst 120,250 were received from abroad, a total of 481,895 messages, against 493,350 in the same period of 1886. The gross receipts amounted to about £30,000 against £31,000 in 1886.

In Norway the question of gas *versus* the electric light is being warmly debated, and in a recent article on this subject the *Technical Weekly Journal* asserts that in Christiania the consumers pay 25 per cent. more for the former than they would do for the latter. Even if the price of gas was thus reduced the profit of the city gas works would amount to £12,000 annually, or 11·3 per cent. interest on the capital. The journal, moreover, calculates that whilst in the factories a gas lamp of 16½ candle-power at present costs 2s. 8d. per hour an electric lamp of equal strength would only cost 1s. 8d. per hour.

Several large commercial establishments in Norway are now being fitted with plant for lighting by electricity, the cost of gas having been found far in excess of that of the latter.

ELECTRICITY APPLIED TO RAILWAY BRAKES.

THE Association of Master Car Builders at its last meeting in Minneapolis (U.S.), came to the conclusion that—"The best brake for long trains is an air brake where the valves are governed by electricity. This kind of brake actually offers four advantages :—

"(*a*) The most rapid stoppage.
"(*b*) Avoidance of sudden shocks.
"(*c*) Most speedy release.
"(*d*) Complete control."

This decision was arrived at in consequence of the results of certain experiments which were carried out on the following systems :—

Westinghouse	...	Electricity and compressed air.
Carpenter	...	" " " "
Eames ...	...	" " rarefied "
Card ...	...	" alone.

La Lumière Electrique describes at some length the various systems experimented on, and we extract from it the following comparative table of results :—

System.	Speed of train per hour, Kilometres.	Distance travelled by trains while stopping, metres.	
		Air brakes only.	Aero-electric brakes.
Westinghouse	32 klm.	65 metres	42 metres.
	64 "	212 "	154 "
Carpenter	32 "	...	35 "
	64 "	...	140 "
Eames	32 "	90 "	80 "
	64 "	280 "	190 "

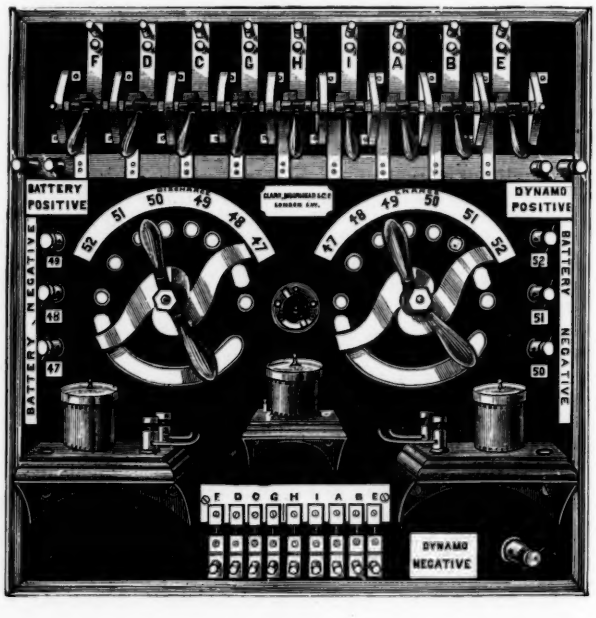
The Card system was withdrawn from competition probably owing to its complicated mechanism, which unfitted it for practical application to goods trains.

THE NEW INSTALLATION AT MESSRS. LLOYDS, BARNETTS AND BOSANQUET'S BANK.

IN a recent issue we gave our readers a general account of the arrangements in connection with the lighting of these new premises, and we are now enabled, through the courtesy of Messrs. Latimer Clark, Muirhead and Co., Limited, the contractors for the work, to give an illustration and description of the main switchboard which they specially designed and constructed for this installation.

This switchboard, which has been fixed in the engine and dynamo room so as to be readily accessible to the attendant, is provided (as the sketch indicates) with two six-way regulating switches, one employed for the charging and the other for the discharging circuit. A voltmeter is connected by one of its terminals to the connecting bar, to which are secured the cables from the positive poles of dynamo and battery, and by its other terminal to the lever of the small switch in the centre of the board. By turning this lever to right or left connection is made with the charging or discharging circuits respectively, and readings are obtained of the E.M.F. at which the dynamo is working, or that at which the installation is supplied.

In addition to the above, two ammeters are permanently affixed, indicating the strength of the current in the two circuits. On the upper part of the board are nine main switches corresponding to the positive cables of the nine sections into which the lamps on the premises have been divided, and corresponding to these, on the lower portion of the board, are nine main fusing bridges, inserted in the nine negative mains.



In order to meet the requirements of the Phœnix fire regulations the whole of this switching apparatus has been substantially mounted on a solid slab of slate 3 feet square by an inch and a quarter in thickness, secured within a polished wooden frame, and thereby attached to the wall. The measuring instruments are Ayrton and Perry spring ammeters and voltmeter, made by Latimer Clark, Muirhead & Co., Limited, to which firm belongs the credit of success in both execution and design.

THE PHILADELPHIA STREET RAILWAY CONVENTION.

THE sixth regular annual meeting of the American Street Railway Association was held at Philadelphia on October 19th, 20th, and 21st at the Continental Hotel, under the presidency of Mr. T. W. Ackley. The attendance was very good, and a noticeable feature was the active participation of a number of gentlemen connected with electrical applications. The convention did little beside discussing electricity in its relation to street cars, as the subject came up at every session and was thoroughly ventilated in all its many and different aspects.

The first morning, October 19th, was largely occupied by the reading of the subjoined paper by Mr. Wharton on

ELECTRICITY AS A MOTIVE POWER.

Since the last annual meeting of this association the subject of using electricity as a substitute for horse-power on street railways has received much attention, and great advances have been made in the practical application of it to that purpose, so that it may now be stated broadly that there is no longer any doubt or uncertainty that electricity can be successfully and economically employed in a great many places, if not most places, as a substitute for animal power. Quite a number of electric railways are in operation in the United States, running satisfactorily under all the requirements of public service, so that there is much greater familiarity with and a more general knowledge of electricity among railroad men and the public than ever before. There is so much confidence in the practicability of electrical propulsion of cars being well established, that the subject is no longer treated with doubt or disdain; on the contrary, great interest and respectful attention are at once manifested whenever the subject is brought up. Although some parties, interested perhaps in pushing forward their own special inventions, may claim too much, the actual facts as presented daily in the regular work of the cars are good enough to warrant this belief and confidence. Electricity in its manifestations, applications, and capabilities has been hitherto a subject the knowledge of which has been confined mainly to scientific circles, but it is evident that the time has come when it will be put in harness in place of the horse to draw cars and to perform many other duties, which a few years ago would have been considered entirely chimerical and visionary. So long as the oxidation of metals or other chemical action was the only available method by which electricity could be produced, the expense attendant upon such means limited its use to a very narrow sphere. Since, however, steam power and water power have been so successfully employed to generate electricity, and to do it so cheaply, the range of its usefulness and application has been wonderfully enlarged from year to year. It is not intended in this paper to make use of scientific terms, or to discuss the question from any standpoint but that of practical observation and experience; nor is it intended that any comparisons shall be drawn between electric motors and steam locomotives, but there is a wide field for work in which neither the locomotive nor the horse is able to satisfactorily accomplish the duty called for.

The systems at present in use for electrical propulsion of cars are divided into two classes.

First, that in which the electricity is conducted from one or more active generating sources along a suitable conductor or conductors to be used in the cars with proper return connections; and secondly, that system in which the electrical power is obtained from accumulators or secondary batteries carried along with or within the body of the car. Of the first there are several methods, namely, that in which the electricity is carried along a conductor above the ground, considerably above the car, either directly over it or toward one side.

That in which the electrical conductor is situated at the side of the railroad and elevated a few feet only above the ground.

That in which the electricity is carried upon the surface, either by a third rail or other conductor, running on the level of the ground or pavement.

That in which the electricity is carried beneath the surface by a conductor placed within a suitable conduit for its protection, access being had to said conductor through a slot in the top of the conduit, so as to allow of electrical connection with the motor on the car.

The plans of having the conductor along the surface or at the side of the railroad not much above the surface have so many evident and practical disadvantages that they need not be taken into consideration in this paper; therefore the question is reduced to the three methods of overhead conduction, underground conduction and storage batteries.

It is evident that better service must be furnished at the same cost, the same service furnished at a cheaper rate, or that both objects combined shall be attained by the use of electricity before it takes the place claimed for it. The writer believes fully that the last proposition of both better and cheaper service has already been proved by actual service and daily use, but in the nature of things, improvements upon the present methods will be discovered, and "the survival of the fittest," which applies as well to mechanical appliances as to animated life, will by its inexorable laws weed out and discard those which are deficient or incompetent. There are so many intelligent, persevering and scientific minds engaged in active experiments and researches into the mysteries of Nature's powers, and more especially those relating to electricity, that discoveries are constantly being made, human knowledge in this age extending more rapidly than at any previous time. The subject is fascinating and the prizes sought after are brilliant and valuable. The increased cheapness in production of electricity which may fairly be assumed for the future, will, of course, add to the advantages, and enlarge the scope, of its use. At present there are many places where electricity can be generated at a nominal cost by the use of water-power, and this energy can be carried a number of miles without any loss or leakage of practical consequence. Where this can be done of course the parties have special advantages. So also there are many towns and cities in coal regions, or natural gas regions, where the same result of cheapness in production can be obtained, although by different means. As a case in point it may be mentioned that the electrical railway in Scranton, Pa., has its power station located about midway of the route, and immediately at the foot of a large hill or great mass of hundreds of thousands of tons of culm, which is principally composed of the small fine particles of coal produced in mining or left after the screening and preparation of the commercial sizes of coal for the market. This has been accumulating for many years, is still accumulating, and has hitherto been considered only an inevitable nuisance, which the mining proprietors would gladly have given away for nothing to get rid of it, and not have it occupy their land. The price which the railroad company pays for this culm is but 10 cents per ton, and as it only has to be wheeled through the door of the engine house, the whole distance from the culm hill to the furnace under the boilers not being over 50 feet, and as the whole consumption per day is on the average but 5 tons, or in money value but 50 cents per day, it is evident that the cost of electricity in this case is exceedingly small indeed, that sum being sufficient for the fuel to produce the steam power which generates electricity enough to run four and sometimes five cars, carrying at times 75 passengers each over a railroad track about four and a half miles in length, having long grades, a number of which are 5 or 6 feet to the hundred, and the steepest of which is 7¼ feet per hundred. The tractive power required upon some of these grades is still further increased by curves or switches occurring on them. It may be well to mention some other points about this railroad in Scranton, which has been running about one year, with great success, and exhibits in many respects a favourable example of an electrical railway with overhead conductors. The cars have four wheels; two of them are open cars, each carrying one motor of 20 H.P. The motor is placed in the body of the car midway of its length, and all four of the wheels are driving wheels, the connections between the motor and the wheel axles being made by means of chains and sprocket wheels. Three of the cars are closed cars, each with one motor of 15 H.P., which is placed on a closed platform at the forward end of the car. In these the forward wheels only are driving wheels, and their connection with the motor is made in the same way as on the open cars, with chains and sprocket wheels. The company will shortly place four more cars upon the line, each with a motor of 25 H.P. These larger cars are intended not only to propel themselves, but to be able each to haul in addition two other cars loaded with passengers up all the grades. The running time of the round trip on the main line, being in all eight miles, is one hour, which includes all stoppages and the waiting at each end of the route, so that the average speed attained is more than eight miles per hour. There is no difficulty in going much faster; in fact, the men in control of the cars have to be watched to prevent their running at excessively high speed, particularly on the return trip to the city, where the grades allow the car to be run for most of the distance by gravity alone. At the generating station there are two stationary engines of 180 H.P. each, two dynamos of 100 H.P. each, and four boilers of 100 H.P. each. Only one engine and dynamo, however, and two of the boilers are in use at any one time. The railway company expects also to furnish in the future electricity for the lighting of the town of Dunmore, situated at one end of the line, by which the income of the company will be materially increased. The duplicate engine and dynamo and the duplicate set of two boilers are for the purpose of providing against contingencies of accident to those in use, and also to allow of alternations in service, thus giving opportunities of frequent examination and inspection. Upon this railway, as before stated, the overhead system of conduction is employed, having flexible connection between the motor on the car and the carrier traversing the conductor, which is a solid copper wire of $\frac{5}{16}$ths inch diameter, suspended on a part of the route from tranverse wires attached to wooden poles placed on both sides of the street about 100 feet apart lineally, about 20 feet high and about 6 inches in diameter at the surface of the ground, and on the rest of the line suspended from arms projecting sideways from wooden poles at the side of the railway about 20 feet above the ground. The line is a single track railroad with several turnouts or passing places, at which points the electric overhead conductor branches off over the side track also, and an ingenious system is in use by which the carrier, running upon the overhead wire, with two grooved wheels of about 2½ inches diameter, automatically shifts the connections at the points of divergence from the main line, so that the carrier always follows that one of the overhead conductors which is above the track upon which the car is travelling. It is contemplated, however, to use two separate and independent overhead conducting wires throughout the whole length of the route, so as to avoid the possibility of any difficulty with the carriers at the points of intersection at the turnouts, although this has not happened often. The return current of electricity is taken by the rails. The electrical current has a tension of about 600 volts, which while sufficient to give a shock, could not produce any dangerous effect on man in case the current should by any means be diverted. Part of the road is laid with tram rails and the rest with T-rails, and a part is paved and the rest unpaved, so that these different conditions, in connection with the many grades and the curves and turnouts, give ample opportunity to thoroughly test the working of the system. Although the overhead wires in this case do not present any more unsightly appearance than the numerous telegraph cables and wires to which we are so accustomed, it is, however, evident that the use of the overhead system will be prohibited in most cities and towns, especially since the general determination to place all electrical wires through cities underground. The noise of the carriers running on the conductors is not much, although it can be readily noticed, but the noise produced by the motors and the chain and sprocket connections is quite considerable. This latter could be entirely avoided by the use of a noise

less motor and a better method of connection, of which motors and connections there are several kinds easily obtainable. Noiseless, efficient and durable electric motors suitable for use on cars can be had in which the weight per horse-power does not exceed 60 lbs.

In a paper of the length to which this must necessarily be limited, it will be impossible to do much more than treat of the subject in a general manner, but it can be stated specifically and certainly that electric railways with overhead conduction have demonstrated beyond a doubt their capability to propel a few cars, even if heavily loaded, at less cost and much greater speed than could be obtainable on railways operated by horse-power. This is true in places where the coal required must be bought at usual rates and the exceptional advantage of fuel at merely nominal cost does not exist as at Scranton, and likewise at Wilkesbarre, where an electrical railway is under construction, upon which the cost of coal used will not exceed 60 or 70 cents per day for five cars.

In the case of electrical railways with underground conduction the effort has been made to give all the advantages of the overhead system, and at the same time remove the objection which in most places is absolutely prohibitive of having the conductors and poles or other supports obstructing the streets. In doing this, however, great difficulties arise, some of them of a very serious character. The costly conduit, with the needful arrangements for drainage and for cleaning out, together with the increased care necessary to provide against the considerable loss or leakage of electricity, which nevertheless generally takes place in spite of all precautions, detract greatly from the apparent advantages of the plan. Many inventions have been patented and numberless devices contrived to overcome the many objections of this method, but there is great room for doubt whether practical success has yet been obtained.

Neither by overhead nor underground conduction have more than a few cars as yet been moved simultaneously upon railways, although many ingenious arrangements are offered by various parties who confidently assert that they can run any required number of cars. This, however, yet remains to be proved. Both plans, also, are open to another serious objection in the entire stoppage of travel on the whole line in case of breakage or derangement of any part of the conducting apparatus or the generating machinery. In this respect they are under the same disability that the cable system of car traction is hampered with. Possibly, by suitable arrangements of duplicate engines, boilers and dynamos, duplicate conductors, and auxiliary, sectional, or relay systems of conduction, this disability, threatening as it appears to be, may be so reduced as to be of no great detriment. This, however, also remains to be demonstrated. Taken altogether, underground conduction does not compare favourably with overhead conduction up to this time. One great trouble with the latter plan, however, is that although it can be used to great advantage and economy on lines running a few cars in towns, or in suburban districts outlying large cities, it will probably never be allowed by the municipal authorities in large cities, which of course are the very places where the advantages of electrical propulsion are needed the most. To move a large number of cars, as for instance upon the Third Avenue or Broadway lines in New York city, the electrical conductor, whether overhead or underground, must be of great size if the current is of low tension; while on the other hand, if a small or moderate sized conductor be used, the current must then be of dangerously high tension, and of course it would then be very difficult to avoid great loss of electricity from leakage.

There remains to be considered the accumulator or secondary battery system. In this each car carries its own supply of energy, and is entirely independent of any method of continuous electrical conduction. No change of track or roadway is required, nor any costly conduit or unsightly poles or other supports, while the cars can run anywhere that a car can be taken by horses. These points are of immense advantage, and are the chief merits advanced by its advocates, independent of its economy over horse-power.

In practice, cars of the size of the usual two-horse cars are provided with about 80 accumulators, weighing when filled with fluid and ready for use about 40 pounds each. These cells are placed under the seats, one-half being on each side of the car. Their combined weight is 3,200 pounds, and the weight of two motors each of 5 H.P. should not, together with their connections to the car axles, exceed 800 pounds, so that the additional weight imposed upon the car is, say, 4,200 pounds, which allows 200 pounds for the apparatus to control the current and for other electrical appliances. This added weight if placed upon a four wheel car may be of disadvantage to the car or to the track. If this should be the case, the difficulty is removed by the use of eight wheels on two swinging trucks, which support the car much better, and distribute the weight upon the track. Both these kinds of storage battery cars are in service with entire success. The charging of the cells is done by a dynamo driven by steam power or any other desirable means, and it takes four hours to charge cells which are able to perform four hours' work. To remove from the car the cells which have done their work and to replace them by freshly-charged cells takes no more time than the time required to change horses. It requires 10 H.P. exerted for four hours to charge the batteries or cells of each car, so that 40 H.P. hours are needed to accomplish it.

The cost of running large stationary steam engines of, say, 200 to 400 H.P., constructed with the modern improved cut-off appliances and other economical devices, has been found, after extensive investigations, not to exceed two-thirds of 1 cent per horse-power hour.

This allowance is a liberal one, and is above, rather than below the actual average cost, including fuel at average market prices, attendance, repairs to engine and boilers, oil, &c. We will, however, take it at 1 cent per H.P. hour: Forty H.P. hours at 1 cent costs 40 cents, which is the cost of four hours' car service, and as the day's work of a car should be taken as 16 hours, we have as the whole cost of a day's supply of electricity four times 40 cents, or $1.60. Since four teams of two horses are required to draw a car for 16 hours, and as one additional horse per car is the usual allowance for sick or disabled horses, nine horses per car are needed for a day's work, which at 50 cents per horse for feed, bedding, attendance, shoeing, &c., is $4.50, against $1.60 for the storage battery electricity. Making extraordinary allowance for possible errors in this comparison, the difference is still astonishing to those who have not looked into the matter critically. With motors properly constructed a speed of eight or nine miles per hour is readily accomplished—in fact, eight miles per hour may be taken as the speed at which such motors will work to the best advantage, and return the greatest percentage of mechanical efficiency. The requirements of street-car service demand variable rates of speed, as for instance, in crowded streets, behind other vehicles, or in turning curves and entering switches it is necessary to go slowly and cautiously; and the weight of the load carried at different times will vary from an almost empty car to one over-loaded. These conditions, together with increased power needed to ascend grades and to start loaded cars, especially on up grades, call for electric motors which will under such greatly varying circumstances respond at all times almost equally well.

There are motors which while engaged in performing an equable work and running at an equable speed, for both of which purposes the motor was specially made, will return 90 or possibly 95 per cent. of efficiency, while the same motor when run at some different speed or under some different load may return but 30 or 35 per cent. So that the average performance of such motors in street car service would probably give only 50 per cent. return of efficiency. Motors can, however, be obtained which will under all the variations of street car work constantly return 75 per cent. of efficiency.

The durability of storage batteries is a point which those interested in other systems are very prone to doubt, but it has been proved in actual use in cars that they will continue in good serviceable condition for eighteen months or two years. Makers of these batteries offer to guarantee them good for two years of street car service. The lead-lined wooden containing boxes will last for many years; the negative plates are good for more than two years, while the positive plates are certainly good for eighteen months, if not more.

The plates being of lead and lead oxide are still of value when they become unserviceable, for the metal can be re-cast into new plates, and the lead can be recovered from the oxide. The first cost of storage battery cars and the engine and dynamos is at present prices considerably more than the first cost of cars provided with suitable complement of horses and harness, but when the saving in first cost obtained by dispensing with the ground and the stables required for horses are taken into account, the balance will in many cases be in favour of storage battery cars. This is of course applicable more particularly to large cities where ground is very valuable. By methods now being introduced into the manufacture of storage batteries, their production will shortly be made at a reduced cost, and their durability increased at the same time.

It should be remembered that the increased speed at which electric cars can travel is so much greater than horses could draw them, that two cars can readily do the work of three horse cars, especially as the electric cars require no time for resting at the ends of the route; but although they can easily do this, so much increase of speed would not be allowed or be practicable through the streets of most cities or towns. It could be done with safety and advantage through wide streets or avenues and in suburban districts. It will, however, be perfectly safe to say that three electric cars can do the work of four horse cars, and, if desired, they can at the same time be of greater capacity than horse cars, for while the horses can do no more no such difficulty exists with electricity. Without referring to the excessive first cost required for the expensive cable traction system, and comparing the first cost of the entire plant and equipment needed for a storage battery electric railway on which three cars will perform the service of four horse cars, with the first cost of the entire plant and equipment of a railway using horse-power, it will be found that the advantage will in most cases be in favour of storage electricity. Let us now compare the operating expenses.

Running expenses of 4 two-horse cars for one year, to wit:

	Dollars.
Conductors, 365 days, at 3.00 dols. each car per day of 16 hours	4,380
Drivers, " " 2.50 " " " " "	3,650
36 horses, " " 0.50 " per day	6,570
	14,600
One year's deterioration and repair of 4 cars, at 200 dols each	400
" " " of 36 horses, at 40 dols. each	1,440
	16,840

Running expenses of 3 storage battery cars for one year, to wit:

	Dollars.
Conductors, 365 days, at 3.00 dols. each car per day of 16 hours	3,285.00
Drivers, " " 2.50 " " " " " "	2,737.50
Electricity, " " 2.00 " " " " " "	2,190.00
	8,212.50
* One year's deterioration and repairs of 3 cars, including dynamos, storage batteries and motors, 1,600 dols. each	4,800.00
	13,012.50

This leaves a balance to the credit of the storage battery cars of $3,827.50.

The fact of each storage battery car carrying within itself its own energy, gives to the individual cars an independence of action which neither the cable traction plan nor the overhead or underground system of electrical propulsion possesses, for all of these depend upon central sources of power, which may at any time be interrupted, so that breakage or accident to any part involves the stoppage of the whole line.

In a sanitary and cleanly point of view the withdrawal of the car horses from our streets would be of great benefit, and this would be accomplished without having, as in the case of the cable railway, an open drain, which, although supposed to be kept clean, in fact nearly always contains a deposit of street refuse to a greater or less extent.

The leakage of electricity in storage batteries, charged but not in use, need not be taken into account for any length of time that cars would probably stand idle. In fact, the leakage from batteries in good condition would not exceed 10 per cent. in three months.

The percentage of mechanical energy given by the steam engine which is recovered in actual work under the variable conditions of street car service on the driving axles, with storage battery cars properly equipped, is at least 40 per cent, and with electricity by direct conduction at least 50 per cent. In cable traction, after deducting the power needed to move the cable and to revolve the wheels guiding and carrying the cable, not over 25 per cent. is left for drawing the cars, and on some cable railways even less.

The increased speed so easily and advantageously obtained on electric railways as a class, not only enables three cars to do the work of at least four horse cars, and effect the great annual saving shown above, but it has a tendency to invite travel and thereby increase receipts, also to give street railways the opportunity to extend their lines advantageously further into outlying districts and to compete on better terms with elevated roads and steam railroads than would be possible with horse-power.

The rapid deterioration and destruction of street car horses shows the exacting and terrible nature of their work, although it is for only four hours per day. Their powers are already overtaxed, and they can do nothing more either in speed or in load carried.

Electric cars, by dispensing with horses, allow more room in the streets for other vehicles, and this advantage in crowded streets is of moment. Take, for instance, Washington Street, Boston, or Broadway, New York, and it will be readily seen that this relief to the clogged traffic would be great.

Electric cars can go backward or forward with equal facility, they are under perfect control, can stop and start more quickly than horse cars, and in case of delay can make up lost time. They never get sick with epizooty or other disease, and during strikes or other periods of enforced idleness do not require to be fed. On down grades they will run by gravity without the expenditure of other force, and on level or nearly level stretches a very little electric energy continues their motion when once they are started.

The electricity, besides running the motors, will supply the car with incandescent electric lights, actuate an electric signal gong, and operate electric bells for the use of the conductors and passengers in stopping or starting the car. It is usual to have the regular hand-brake for stopping the cars, but the motors can be instantly reversed by electricity if desired. This method, however, should only be employed when it is necessary to stop the car very quickly to avoid accident or for some other imperative reason. By this means the car can be stopped in much less distance than is possible by the hand-brake, which, of course, operates with the same efficiency whether upon electric cars or horse cars.

It has been questioned whether in winter, when the tracks are liable to be obstructed with snow or ice, the electric cars will be able to propel themselves, owing to the fact that they obtain their power of propulsion from the adhesion of the wheels upon the rails, so that if the wheels are prevented from reaching the track there would be a great liability of their slipping and turning around without giving any forward motion to the car itself. In answer to this, it may be stated that during last winter on the electric railway in Scranton, having the overhead conduction system, and from experiments made in Philadelphia with a storage battery car, it was found that there was no unusual difficulty presented in snowstorms, the wheels, owing to the added weight, settling more readily through the snow, and thus reaching the rails. Upon roads properly equipped with snow-plows, or snow-sweepers with revolving brushes, propelled by powerful electric motors, the clearing of snow from the tracks would no doubt be much more efficient than horse-power could effect. Street car electric motors of 50 H.P. or more, if required, can be as easily made, and are as easily controlled as motors of 5 or 10 H.P., so that electricity has ample ability to keep the tracks clear from accumulations of snows. As with locomotives, sand-boxes should be placed upon electric cars, so that if any slipping of the wheels should be observed, either from the greasy, slippery condition of the track, sometimes seen in damp weather when the streets are not properly cleaned, or from snow or ice upon the track, the driver, by opening a suitable valve, can let out a little sand upon the rail, and at once overcome the difficulty.

It is sometimes asked why two motors of 5 H.P. each should be needed upon a car usually drawn by two horses. In explanation of this it may be stated that a car horse can, and very often does, exert for a short time in starting a car or upon steep grades a force of five or even more horse-power. A mechanical horse-power is the measure of the moderate duty which a horse can constantly and regularly exert day after day in a regular day's work without injury; but car horses are constantly temporarily called upon to exert unusual and unreasonable power, which is the reason they are so rapidly destroyed in street car service. It is evident, therefore, that the electric motors must be able, when called upon, to exert the same power that the horses under pressure can be made to perform temporarily, so that a maximum of 5 H.P. in each of the two motors will develop only such force as the requirements of street car service are constantly demanding during short periods of time.

It is not intended in this report to indicate that cable railways for use on steep hills or high grades will be superseded by electric railways, for the latter are limited to such grades as the adhesion of their wheels upon the rails will enable them to surmount, just as in the case of the steam locomotive, so that there is a suitable and proper sphere of usefulness for cable railways in the many places for which they are particularly adapted.

It has been proposed to increase the tractive power of electric cars upon inclines by causing magnetic attraction to be developed between the wheels and the rails, and also by the use of other devices. All these methods present complications which probably will more than outweigh the advantages sought to be attained.

In developing the best construction and management of electric cars and railways, careful attention to details, some of which at first sight may appear trivial, should be exercised, in order to obtain the best results, no matter which of the three plans be adopted. It should, however, be said that in practice at the present time the running of electric cars requires no more intelligence or skill than the running of horse cars, and also that the electric current with continuous conduction on lines using a few cars, need not be of such tension as to endanger human life, 500 volts being sufficient. With the storage battery system the tension of the current is so low, 160 volts being sufficient, that no shock whatever could be experienced by a man taking through his body the wholy current required to propel the car. This has been repeatedly done, some of the people stating they felt nothing at all, and the others no more than a slight tingling sensation.

The term "storage batteries" so generally in use, is apt to give a wrong impression, no electricity whatever being stored or contained within them, for in charging the batteries a chemical action is forced to take place, and when this chemical action is allowed to reverse itself electricity is generated thereby. The car motor immediately uses this, and when the motor is stopped the chemical action and, therefore, the generation of the electricity ceases.

In this report care has been taken not to refer by name to any patented inventions, or to recommend any particular make of electrical appliances. As to these matters, those proposing to use electricity, whether by overhead or underground conduction or by storage batteries, should of course be careful to select such methods as are the most reliable, efficient and durable, and to deal with parties not only responsible as to the validity of their patents, but capable of doing what they undertake to perform.

Any one who peruses the railway journals and notices the number of electric railways now in operation, and the still greater number of those in course of actual construction or projected, has cause for surprise, if he has not closely been following the course of events.

That electricity, by some of the present methods of its use, or by better ones yet to be invented, will entirely supersede the use of horses and cable traction upon all street railways, excepting under the special conditions for which cable traction is occasionally applicable, is a question that admits of very little doubt.

GOVERNMENT AND THE CABLES.

THE announcement of the Central News, which appeared in our issue of last week, with respect to the contemplated action of the Government in regard to the channel cables, has been followed by the following communication to the Press by Sir S. Arthur Blackwood: "The Postmaster-General directs me to request that you will have the goodness to allow him to state by means of your columns that the detailed statements which have recently appeared in the Press on the subject of telegraphic communication between this country and the Continent were entirely unauthorised, and that the information conveyed was in many particulars inaccurate and misleading."

The Central News, not at all dismayed, repeats its assertions, says it is in a position to confirm them, and adds that at the Cabinet Council on Tuesday last week the whole question was discussed, the petition of the Submarine Telegraph Company to have the concession renewed to them being presented to the Cabinet by Mr. Goschen, by whom it was to some extent supported. Ministers, however, definitively rejected the petition, and instructions were immediately given to the Foreign Office to continue the negotiations with the French Government first opened by the British Post Office authorities for the completion of an agreement to themselves work the cables between the two countries without the intervention of any telegraphic company. This decision was formally notified to the directors of the Submarine Telegraph Company on Friday night.

In carrying out the arrangement with Germany, continues the Central News announcement, the authorities a week ago had

interviews with Dr. Lazard, and it was then announced that the German Government had agreed to purchase the cable and plant of the German Union Telegraph Company. This cable is known as the Lowestoft-Emden cable, and is in good order. The German Government has acted throughout this matter in the most cordial spirit with Great Britain. The Post Office owns the cable running from Lowestoft to Nordesney, and application will be made to Parliament early next session for the necessary grants to complete the purchase of those cables which the Government intends to buy. In order to effect improvements in the telegraphic service, the Post Office has practically decided to have direct telegraphic communication between Liverpool and Havre, Liverpool and Hamburg, Liverpool and Antwerp, and possibly between Manchester and Paris. The Post Office has further under consideration the desirability of having a central foreign telegraph station in Threadneedle Street, London, which would be close to the Stock Exchange. The Post Office already owns a building in this street, which would require, however, to be greatly enlarged in view of the extension of traffic expected. It has not yet been decided whether, if the Post Office agrees to buy up the Submarine Telegraph Company's cables, they will take over the staff of the company, but it is expected that they will do so. Although the Post Office declines to pay anything for the goodwill, the Submarine Telegraph Company will still be able to pay its shareholders par value for their stock, as the company has a very substantial reserve fund, and its cables and plant will realise a fair sum. But it is understood, as the Post Office has declined to pay for any goodwill, it will not be practicable to maintain the high premium at which the shares now stand.

In commercial circles, according to our authority, the resolution of the Government is generally applauded as tending to the benefit of the community generally. In some quarters there is a disposition to believe that the action of the Post Office will not end here, but that they will take into their own hands the telegraphing and the receipt and delivery in this country of all messages sent through telegraph companies having cables landing on British shores. This would restore confidence in the secresy of the service, and prevent those suspicions of preference given to "directors' messages" whenever any very startling news arises which has caused from time to time so much comment.

The expectation of a reduction of rates has also been very favourably received. It is quite possible that the British Government may be able to effect this without reference to the Telegraphic Union, the articles of which provide that any two countries may mutually arrange a reduction of rates without reference to the Union. It is therefore hoped that a reduction of rates will be officially announced by the Post Office directly they commence working the Continental wires. It is believed that the question of a special reduced rate for Press messages will be one of the matters discussed between the English and French Governments, and one that will in all likelihood be conceded.

THE ELECTRIC LIGHT IN LEAMINGTON.

LEAMINGTON has taken the lead among the towns in the Midlands in the adoption of a general system of electric lighting. The concession for the lighting of the town has been granted to the Midland Electric Light and Power Company, Limited. The present arrangement as to terms, which is practically for three years, is exceedingly favourable to the Corporation and the private consumers, the promoters of the company hoping to profit largely by the splendid advertisement which they expect to derive from the successful lighting of a fashionable town like the Royal Leamington Spa. The project has been taken up warmly by the inhabitants. The Town Council has accepted the company's offer to light Bath Street and the Parade—having in their last contract with the gas company taken power to dispense with the use of gas in certain parts of the town—the Town Hall and Free Library, and the Pump Rooms. The Theatre Royal, the Warwickshire Liberal Club, the Bath Hotel, the Angel Hotel, the establishments of Messrs. Wackrill and Sons and Messrs. Francis and Sons, a large number of the leading shops in the Parade and Bath Street, and the private houses of Alderman Bright and Councillor Fell have also been fitted with the new lights. The total number of lights ordered up to the present time is about 1,500, but it is confidently anticipated that 6,000, the number for which machinery has been laid down, will be wired in the course of twelve months. The Corporation and the private consumers provide their own fittings, but the mains and the producing plant are the property of the company. The lighting at present is entirely by incandescent lamps. Storage batteries are not used, though they can be adopted, if thought advisable. Meanwhile the current is supplied to consumers' houses direct from the central works, and is intended to be maintained day and night, every hour of the twenty-four, and every day of the week.

The establishment where the current for electric lighting is generated is built on the company's freehold land in Wise Street, and the compactness of an electric lighting plant is admirably illustrated by contrast with the neighbouring gasworks. The site adjoins the Birmingham and Warwick Canal. The engine and dynamo house is 91 feet by 84 feet 6 inches. In order to give the necessary solidity, the massive machinery used in the shed is bolted to a foundation consisting of 500 cubic yards of concrete and masonry. The chimney, an octagon stack of 78 feet in height, is near one end of the coaling room. The architect was Mr. J. A. Cossins, of Birmingham, and the builder Mr. J. Fell, of Leamington. About twice as much land as is covered by the present works remains in the company's possession for future extensions. Three locomotive-type boilers supply the steam to the engines. These boilers are entirely of Siemens-Martin steel, and are of the highest class of workmanship. They are much larger than any to be found upon locomotive engines, having a total length of 19 feet 3 inches, with an external diameter of band of 5 feet 1 inch, and a total heating surface of 740 square feet. The boilers are all tested by hydraulic pressure to 300 lbs. per square inch, and are suitable for a working pressure of 140 lbs. There will be practically no smoke visible. There are three pairs of large horizontal engines in all, each capable of exerting 200 effective horse-power, and designed and constructed expressly for this installation by the well-known firm of Messrs. Robey & Co., of Lincoln. They are upon the compound principle, having high-pressure cylinders of 15 inches and low-pressure ditto of 26 inches diameter respectively, the stroke of both being 2 feet 4 inches. The high-pressure cylinders are fitted with the Proëll automatic valve gear, controlled by the Richardson electric governor.

The electricity is generated by six of the Hookham patent dynamos, each capable of supplying 1,000 incandescent lamps of 18 candle-power each. Each dynamo weighs 72 cwt., and occupies a floor space of 8 feet by 5 feet. The power is communicated to the six dynamos through a line of intermediate shafting, which stretches across the whole width of the engine-room. Each engine is fitted with a heavy grooved fly-wheel, 10 feet diameter, driving a similar grooved pulley on the countershaft by means of nine 1¼-inch cotton ropes. Six more grooved pulleys of 6 feet diameter upon the shafting drive the dynamos by ropes in exactly the same manner. Cotton rope has been used as the means of transmission in preference to leather belting, as the irregularities in thickness at the joints in the latter would seriously affect the regularity of running at the dynamos, the numerous ropes giving a practically uniform rotation. Another advantage gained by the use of a number of ropes instead of one pulley is the avoidance of inconvenience caused by breakage. Should one rope break the others will suffice to keep the machinery in motion, and the broken one can be replaced at leisure; whereas the failure of a single belt would mean a total stoppage of the dynamo to which it may be attached.

The precautions against breakdown have been so carefully worked out that a stoppage in the supply of electricity seems almost beyond the range of possibilities. In the first place, two of the three boilers are amply sufficient to supply the three engines, the third being a stand-by. The steam-pipes are so arranged that any given boiler can supply any one or more of the engines. By means of friction-clutches any engine can be instantly detached from the main shafting and another substituted, and the same holds good with each of the dynamos. The shafting itself is in three separate lengths connected by two friction-couplings, either of which can be slackened off without shock or stoppage. In addition to the electric governors before mentioned, the engines have a second, or safety governor, of the centrifugal type, which would take up the running if such an accident as the breakage of a wire should cause a failure of current through the electric governor. There are also fusible cut-outs on each dynamo to protect these as well as the main leads from accidental short-circuiting. Then there are the main switches, 12 in number, arranged in order on an enamelled slate-board, measuring 8 by 5 feet. After these, come the galvanometers, one on each main, showing the pressure on the main by means of an index finger moving in front of a graduated dial; by the side of these are resistance boxes, connected with the field magnets of each dynamo so as to control the electromotive force by hand in the event of the automatic electric governor failing to act; and, finally, there are five registering meters, manufactured by Chamberlain & Hookham, Limited, under Mr. Hookham's patents, which measure and record the current passing along each feeding main. Meters of similar construction ultimately will be supplied to the consumers. It is claimed that this meter, which was invented by Mr. G. Hookham, satisfied the long-felt requirement of an instrument at once simple and accurate for measuring the electric current, and that its invention will have a great effect on the future of electric lighting and the distribution of electricity for motive purposes. It records the amount of current consumed, the result, reckoned in Board of Trade units, being read from dials similar to those to which the public are accustomed in gas and water meters. To give an idea of its sensitiveness, it will start with one-third of the current used in a single lamp, while it will carry sufficient for 150; its rate of rotation never exceeding about 80 per minute. But, notwithstanding this extreme sensitivess, it is anything but a delicate instrument in construction; and will, so far as the patentee has been able to test it, run for years without touching. With any number of lamps above three the readings of the meter are perfectly correct; for a smaller number they are slightly in favour of the consumer. The current is taken from the dynamos through the instruments described above along two sets of feeding mains carried in brick trenches to two distributing boxes, the one placed near the old well, the other by the corner of the Parade and Holly Walk. The trenches were dug from the company's works to the lower end of the Parade, and then continued on either side of the Parade to its upper end, with a branch at the Town Hall to the end of Holly Walk. The contract for these was placed in the hands of Mr. Fell. The cables were laid on wooden bearers, sup-

ported on slate brackets, the whole being covered with slabs of stone. From the distributing boxes the current is led by distributing mains to the various consumers in the town. The principle of distribution adopted by the company is known as Dr. John Hopkinson's three-wire system, by which, without increasing the electromotive force, a saving of about two-thirds is effected in the weight of the copper conductors, the sections of all of which were calculated by Dr. J. Hopkinson himself. The conductors were supplied by Callender's Telegraph and Bitumen Company, Limited; their insulation resistance is equal to 500 megohms, at 65 degrees Fahrenheit, and their total length is 13¼ miles. The length of the trenches is 3,500 yards, and the distance from the engine house to the furthest consumer is 1,850 yards. These distributing boxes are also utilised for street lighting, circuit switches for the street lamp wires being placed therein, so that the whole or any section of the street lamps can be lighted or extinguished in a moment. The total number of new standards erected on the Parade and Bath Street is 70, viz., 50 with single lights and 20 with three lights, making 110 lights in all; but when the arrangements are complete the existing gas lamp posts will be transformed into electric light posts, bringing the total number of public electric lights in Bath Street and Parade to 183. The light which the company contracts to supply is equal to eighteen candles, the whole of which, by the aid of silver-plated reflectors, is thrown on the streets. The charge, which includes lighting, extinguishing, and cleaning, is to be the same per lamp as is at present paid for the gas. At the Town Hall there are 349 lights, and at the Pump Rooms 166. The cost to the Corporation of the standards and fittings for the Parade and Bath Street was £542 10s., the fixtures and lamps for the Pump Rooms necessitated £212, and those for the Town Hall £475 11s. 6d., or a total initial expense to the Corporation of £1,230 1s. 6d. The electricity will be charged to the consumers at the rate of from 7d. to 4d. per unit, or from about ¼d. to ½d. per lamp per hour. The "unit" of electrical supply, as defined by the Board of Trade, is an hour's supply of 1,000 volt-ampères. The capital involved up to the present time has been about £30,000, and the company anticipate that when the plant is fully employed they will earn a dividend on this of from 7½ to 12½ per cent. The whole of the work has been planned by Chamberlain and Hookham, of Birmingham. The dynamos and electrical apparatus have been manufactured by them, and the other machinery has been made to their specifications and supplied by them to the company. The resident engineer to the company is Mr. Fred. Thornton, who has had a large experience in electric work. The laying of the cables and the wiring of the various buildings has been effected under his superintendence, and have given entire satisfaction.

On Tuesday the 8th inst., shortly before dusk, the Mayor (Mr. S. T. Wackrill) with most of the other members of the Corporation, the medical officer of health (Dr. Baly), the borough surveyor (Mr. D. Normanville), the Mayor of Warwick (Mr. S. W. Stanton), and a number of the principal residents in Leamington and the neighbourhood, met Mr. A. Chamberlain, Mr. G. Hookham, and the engineer at the works in Wise Street. Mr. Chamberlain having shown the party over the establishment and described the apparatus and its mode of working, the Mayor made a few congratulatory remarks, in the course of which he attributed the slow progress of electric lighting in this country to the comparative cheapness of gas. His Worship then started one of the engines, and switched on the current to the lamps in the engine house, the street lamps, the lights in private houses and shops, and the minor lights at the Pump Rooms and the Town Hall. A loud cheer was given as soon as the soft but brilliant light of the electric lamps appeared. After further inspection and explanation, the party started for the Pump Room. The electric lights in the shop windows proved highly effective, especially where drapery, pictures, or fancy goods were displayed. The excellent way in which the light brought out the colours of the articles on view, and the fact that, there being no danger of fire, the lamps may be distributed entirely with regard to effect, seemed to be the chief factors in this highly successful result. The effect of the street lighting was not so gratifying. The light itself was brilliant enough, but being hung on a bracket projecting from the lamp-post, instead of shining from the top it cast a dark shadow across the road. The fact that no light was allowed to escape at the top—all of it being thrown downwards by the reflector—made the lanterns, which are similar in size and shape to the lamps in railway carriages, look somewhat puny by the side of the large gas lamps, with their flaring jets, on the opposite side of the street. As far as one could judge, however, the amount of effective light emitted by the electric lamps largely exceeded that given by their old-fashioned rivals. Where the lights were exhibited in twos or threes the effects was highly pleasing, and it would seem that fewer lamp-posts, each having a group of lights, would be a better way of carrying out the illumination of streets by the incandescent system. At the Pump Rooms the corridors and small apartments were found to be splendidly lighted by single and grouped lamps. The historic Pump Room itself, however, was in darkness. The party assembled in the room, and the Mayor having given the word, there was instantly a brilliant illumination. In this case each of the places in the ceiling occupied by the old "sun" gas-burners has been filled in with 12 incandescent electric lights. Each lamp bulb is mounted, according to a method devised by Messrs. Chamberlain and Hookham, in a bell-shaped mirror, the reflecting surface of course being on the inside, and the curve being designed to aid the effective diffusion of the light. The result of the switching on of the current was hailed with another loud cheer. The next p'ace visited was the Town Hall, the front and portico of which were already brilliantly illuminated, in a manner which would be exceedingly serviceable in the event of a ball or other assembly causing the use of a large number of carriages. At a signal from the Mayor the lights in the main corridor downstairs and those of the principal staircase were turned on with satisfactory results. The lighting of the staircase effected by a row of 12 mirror-mounted lights overhead, was particularly admired. The lighting of the Assembly Room, however, was the crowning success of the undertaking. The jets of the sunlights have been replaced by the same number of arc lamps mounted in the same way as those at the Pump Room. A glorious light flooded the hall, and evoked an almost simultaneous wish among the spectators to see the effect of its effulgence on one of those assemblies of "fair women and brave men" for which the hall is so well adapted. The lighting of the Free Library and other rooms having been inspected and pronounced satisfactory, the party assembled in the Council Chamber, which was illuminated very effectively by two handsome pendant electroliers of 14 branches each.

The MAYOR, putting on his chain of office, congratulated his colleagues and the inhabitants generally on the progress of electric lighting and the successful inauguration of the system in Leamington. He also expressed to Messrs. Chamberlain and Hookham the obligation the town was under to them for the favourable terms which they had made with the Corporation and the consumers, and the admirable way in which they had carried out the work.

Mr. A. CHAMBERLAIN, in reply, said that the Mayor, during his four years of office, had assisted in many important projects for the benefit of the town; but he thought that his worship would regard this, the closing public act of his mayoralty, as worthy to hold a place with any other in which he had taken part. Having explained the advantages of the electric light in point of cleanliness, health, brilliancy, and coolness over gas, oil, and other illuminants, Mr. Chamberlain argued that Leamington would advertise not only the Electric Light Company but itself by the step it had taken. The people of Cheltenham were discussing how they might best advertise their town, and he commended to them the example of Leamington. He hoped the consumers would bear with any imperfections that might appear in this the largest and most complete installation of the electric light yet attempted in the United Kingdom, and would appreciate the efforts of the company to improve the service from time to time. He did not think that his company and the gas company would try to cut one another's throats; they were too sound men of business, he hoped, for that; but the competition would be beneficial, as it already had been, to the consumers pecuniarily, and would stimulate both companies to efforts at improvement. The consumers had been promised that the electric light should cost them not more than 30 per cent. more than gas, but they were giving them in their streets electric lighting at a cost, light for light, less than that of gas. The economy of electric lighting depended largely upon the consumer; but he would point out that the price charged at Leamington was equal to about 10s. per annum per lamp, as compared with from 30s. to £2 2s. in other towns where electric lighting had been tried. At present, however, the company were making no charge whatever for the supply, which would be continued free for at least the whole of this month. During that time, however, as the works were not quite complete, the supply would only last from dusk till about 11 o'clock. In the course of the month every consumer, he hoped, would be supplied with one of Mr. Hookham's meters, which could be read as easily as a gas or water meter, and would assist them in practising due economy in the use of the light. As to the street lights, only one-third of the proper number had been fitted as yet. It had been suggested that they should have the arc light in the streets. The effect of that, however, would be, he thought, to make the ignorant stare, but the judicious grieve. It would entirely spoil the effect of the lights in the shop windows, and that, he thought, was not what they wanted in Leamington.

At the conclusion of the proceedings the company adjourned to the Mayor's Parlour, where refreshments were supplied, and the health of the promoters, on the proposition of the Mayor, was cordially honoured.

Afterwards the public were admitted to see the effect of the light in the various parts of the building.

PUMPING BY ELECTRICITY IN COAL MINES.

THE electrical pumping plant hereafter described was built by Messrs. Immisch & Co., Kentish Town, London, and erected under their superintendence; the steam power, the pumps and piping being supplied by the colliery owners. The particulars and a test of the plant are appended, and will serve to show, that even with ordinary steam engines, and pumps not specially designed for use with electrical plant, the commercial return of useful work is very high. Indeed, the efficiency of electrical plant is as much as 66 per cent. in

favourable cases. And, since the efficiency falls off very slowly with the increase of distance through which the power has to be transmitted, this method of driving pumps should find favour in mining circles.

Where steam can be used direct, or be easily carried by lagged pipes, and in most cases where the power can be transmitted by a system of ropes, the electrical engineer will not enter the lists. Electricity really competes with compressed air and hydraulic plants.

Comparisons which have been made show the following results :—

Compressed Air Plant.—Pneumatic plant entails a large initial outlay, gives considerable trouble whilst running, from heating at the compressors and freezing at the exhaust ports. The running expenses are also very heavy. The losses in transmission through horizontal pipes for long distances are also considerable. Against these must be set off the fact, that there is a slight increase of pressure when vertical pipes are used for any part of the way, and that the exhausting of fresh cold air is, near the "faces" at any rate, a great boon.

Hydraulic Plant.—Water under pressure is in many cases a very cheap and convenient way of transmitting power, and if there be a sufficient head to do away with the need of a pumping engine and accumulator on the surface, there is much to be said in its favour.

In most cases, however, an engine and accumulator will be required on the surface, and heavy costly piping has to be laid down. The chief drawback is that water has to be taken down the mine to raise water already there. Cases are known where a gallon of water at high pressure was used for every two gallons raised.

The plant is costly, and, if working at high pressure, gives continual trouble by blowing of joints, &c. The cost of maintenance is thus sometimes considerable.

Electrical Plant.—The requirements for this are a steam engine and boiler, a dynamo, motor, and connecting copper cables.

The engine and boiler may be taken as common to all the systems, and the cables are comparable with the piping used in the other systems. The cable is, however, less per foot run than either cast or wrought iron piping to transmit the same energy, and the cost of erection is far less since there is no jointing to be done. The cable is cleated to the cross timbers on the roofs in a simple and cheap manner.

We have now only the dynamo and motor to compare with the compressors, accumulators and air engine of the pneumatic system, or the accumulators and engine of the hydraulic. It will be found that the air compressors, accumulators, and air engine cost about as much as the dynamo and motor for a similar output. The hydraulic accumulators and engines will cost less than the dynamo and motor, but the want of efficiency and other drawbacks mentioned, more than counterbalance this apparent gain in prime cost.

Briefly then, an electrical system has about the same initial cost as a pneumatic one, and the hydraulic is cheaper than either.

The cost of maintenance of the electric system is, however, far less than either, but exact comparison cannot yet be made, owing to want of data. The dynamo and motor have only the journals, bushes, commutator, and brushes as wearing parts, and even allowing the highest rate of maintenance ever experienced in these machines, the cost will not exceed 5 per cent. per annum of the prime cost.

The high efficiency of electrical plant for transmitting power over long distances, also enables a smaller boiler and engine to be laid down ; and thus there is a further saving in initial outlay.

A single cylinder horizontal engine was used. The bore was 14 inches and the stroke 15 inches. The steam pressure was varied by a reducing valve according to the work required.

This engine was an old girder engine. During the test it was found that the slide valve nuts had shifted on the bottom end. The diagrams are thus defective, since the steam was admitted too late and cut off too soon on the bottom end. This must have lowered the efficiency of the engine to some extent, and, of course, is against the net efficiency of the system. The power required to overcome the friction of the engine and dynamo without any load was 1·715 H.P.

The motor ran at a speed of about 650 revs. per minute during the test, the pumps making 8 revs.

The gearing consisted of three transmissions. The first a 10-inch cotton belt, the second a mortised pinion gearing into a cast iron wheel, and the third a cast iron pinion and a wheel on the crank shaft of the pumps. This complex system for reducing the speed of the motor was, of course, not orginally designed so, but circumstances made it convenient to use gearing in this manner.

The pumps were made by Messrs. Bradley & Co., of Wakefield, to the design of Mr. Brown, the engineer at the colliery. They consisted of two separate differential pumps. Each had one 6-inch ram, and one 4½-inch ram. They were coupled by cross heads and connecting rods to the main shafts with the cranks at right angles.

The suction was only made by the 6-inch rams, but all the rams delivered water into the column ; there were thus two sections and four deliveries per revolution of the crank shaft, the pump being equivalent to a four-throw pump with 4½-inch rams.

The division of the work done by the large rams was not by any means equal. Though to casual inspection the work done throughout a revolution was constant, an ammeter in circuit with the motor showed considerable fluctuations of current at regular periods. The difference of load thus experienced was as much as 25 per cent., and caused at first some trouble by heating the armature and pole-pieces, if the average current exceeded 50 amperes.

This difficulty, however, was successfully overcome. The same plant was tested under different circumstances about three weeks before these tests were made, and the conversion was then 42 per cent. with a delivery of about 42 gallons per minute through 850 feet. The rise of efficiency to 44·4 per cent. is probably

PUMPING PLANT AT ST. JOHN'S COLLIERY, NORMANTON.

Pumps delivering 39 gallons per minute through a head of 530 feet = 6·3 H.P. in the water.

Work done.	Speed of engine.	Volts on dynamo.	Average amps. given out by dynamo.	E.H.P. given out by dynamo.	Work done in cylinder of engine.	Efficiency per cent.	Loss in cables res. 29 ohms 800 yds. 19/16
Pumps delivering 39 gallons per minute ...	86	171 173·5	47·5 47·5	10·9 11	14·2 H.P.	6·3 / 14·2 = 44·4	·88 H.P.
Pumps running with the suction clack lids off and the column empty.	86	134 128 127	28 28 26	5 4·82 4·45	6·3 H.P.	...	·305 H.P. ·305 H.P. ·265 H.P.
Motor and first motion shaft only ...	88 86	111 105	20 20	2·96 2·8	4·8 H.P.	...	·156 H.P.
Dynamo only, running on open circuit ...	86	0	0	0	1·715 H.P.	...	0

due to the friction of the bearing surfaces being lessened by wear and by the shortened length of piping. But more so by the introduction of the belt transmission which protected the motor from the vibration, which is inseparable from high pressure pumping plant.

We may mention that this plant is giving great satisfaction, and that the colliery owners, Messrs. Locke and Co., have given the makers, Messrs. Immisch & Co., an order for another dynamo and motor to deliver 120 gallons per minute, through a head of 900 feet. The plant is already in hand, and will shortly be delivered.

THE AMERICAN SYSTEM OF ARC LIGHTING.

THE American Electric Manufacturing Company, of New York, has recently appointed Mr. C. R. Heap the manager of its business in England, and this gentleman has commenced operations by supplying a plant for 50 arc lights and a 2,000 candle-power search light for the Panorama building, York Street, Westminster, in which is shortly to be exhibited a gigantic representation of Niagara.

The company owns a complete system of its own, comprising dynamo, automatic current regulator, arc lamp, and numerous accessory apparatus, the good qualities of all being ascribed to the practical experience and careful study of the electrician to the company, Mr. James J. Wood. The "American" system has become well known across the water, and was the one selected (though not a competitor) to illuminate the statue of Liberty recently erected at the entrance to New York Harbour. As an indication of the magnitude of the business now being done by this company in America, it may be stated that during fifteen weeks ending on the 31st of October last the necessary plant was sold for installations amounting in the aggregate to over 3,400 arc lights.

The plant now ready for use at the Panorama comprises two 35-light dynamos, fitted with Wood's automatic current regulator, and 50 arc lamps, all of 2,000 C.P., mostly of brass of a highly ornamental character, and fitted with Mr. Wood's re-lighter, which so controls the carbons that if the light is extinguished by any accident the carbons are automatically brought into contact and immediately relighted.

It is, however, upon the dynamo that the company stakes its reputation, contending that in cost of construction, economy of power and maintenance, durability, safety of the armatures from burning, and simplicity of action, it is, if not unequalled, at any rate, unexcelled. A reference to some of its details may be interesting. The armature is made in the form of a ring of soft iron wire closely covered with coils of carefully insulated copper wire so placed as to prevent the possibility of a short circuit between them. The centre is composed of a gun metal "spider" so constructed as to give perfect ventilation and affording the greatest strength with the least weight. The "spider" absorbs any undue heat that may be electrically developed in the ring. The heat is so quickly dispersed by the current of air produced, that the tendency to overheating is entirely removed. As to the commutator the narrow copper plates of which it is composed are well insulated from each other, and are so built that one or more sections may be readily removed without in any way interfering with the others. Where the ends of the armature wires in each of the coils are attached to the commutator clamps, they are enlarged so as to increase their strength and lessen their tendency to vibrate or break. By a screw or clamp of patented design these ends of wire are connected with the radial arms of the commutator thus enabling any section or coil in either armature or commutator to be easily removed or replaced without the least disturbance to any other part of the machine.

The action of the automatic current regulator is simple and reliable, of which we had ocular demonstration at the installation to which we have referred, the engine on the occasion of our visit having been unavoidably worked without a governor, owing to the slipping of a belt. In spite of the entirely uncontrolled and very varied speed of the engine the regulator answered instantaneously every demand made upon it, and the lights did not vary in the least. The regulator is so correct in its action that from one light to a full number on a 50-light dynamo may be turned off at once without endangering the safety of the machine.

As a result of the constancy of the current thus secured, the company's lamps will burn the commonest of carbons, experience having shown that rods at £6 10s. per thousand are to be preferred to some which can only be procured at three or four times the outlay.

The engine employed at Westminster is a Robey of 35 horse-power.

OPPERMANN ELECTRIC LIGHTING AND MANUFACTURING CO., LIMITED.

TO associate the name of Oppermann with anything electrical is perhaps a questionable policy, but that such a name as that of the chairman of the above company (Lord Edward Spencer Churchill) should be associated with the above title is to say the least unfortunate, if the general public should be thereby unduly influenced to lend its support, irrespective of the merits of the concern.

We wonder if Lord Edward Spencer Churchill and Mr. Alexander William Hall, M.P., know anything of the previous history of the concern the company proposes to acquire.

Paragraph 1 of the prospectus speaks of the well-known business of electrical engineers now carried on by Mr. Carl T. J. Oppermann under the name of Lawrence Oppermann at Crown Works, Amherst Road, Hackney; yet this same Carl T. J. Oppermann stated at his public examination at the Bankruptcy Court on May 6th, 1886: "*My brother and employer is a minor, but he is not carrying on the same business that I formally had, although he may have some of the same customers. He pays me £3 a week. I do not know what he takes himself. I am not the manager.*"

Well, since that date, Mr. Carl T. J. Oppermann may have purchased this "well-known" business from his brother, the minor of May 6th, 1886, but if this is so, it is important that intending subscribers for shares should ascertain what he gave for it, and thoroughly investigate the prospects of this newly acquired business, seeing that large losses resulted from the carrying on of Mr. Carl Oppermann's previous business, and that the books of this previous business were at the date of the bankruptcy not made up to anything like that period to the satisfaction of his creditors. Anyway, the books of the "well-known" business which, according to Messrs. Kidson & Hanning, show a profit of 30 per cent. on the capital engaged, do not probably cover transactions of any considerable time, and therefore not much value is to be placed on such a statement.

Possibly the ability of Mr. Carl T. J. Oppermann would enable him to conduct a very extensive business without much capital, and it therefore seems a pity that the public should be asked (and possibly induced, by the exhibition of the names of some apparently and, so far as we are aware, really respectable directors) to put capital into a business which the vendor may be capable of conducting without.

[The registration of this company, &c., can be found notified in the REVIEWS of November 4th, p. 471, and November 11th, p. 495.—EDS. ELEC. REV.]

Berthoud-Borel Cables.—Our contemporary *La Lumière Electrique*, in mentioning the specification of Berthoud-Borel and Company for cables for alternating currents, says that though the plan proposed seems to be excellent, the cost must, on the other hand be very great.

THE ROYAL JUBILEE EXHIBITION, MANCHESTER.

THIS exhibition closed according to notice on Thursday, the 10th inst., and there was then brought to a conclusion an exhibition the most successful of its kind ever held with the exception of that held in London last year. It will long be known as the "Gem of the Jubilee," and will, we have no doubt, be especially remembered as having on view in its fine art galleries the most extensive and valuable collection of paintings by British artists ever brought together.

The electric lighting of this exhibition, which has been described in these columns, has been on a larger scale than ever attempted before in similar buildings, and we need only mention here that the lighting throughout the exhibition and grounds has been from the commencement to the end most satisfactory, but there are some points and details connected with the working we must defer to our next issue.

Although in the prospectus of the exhibition, and during its progress, much was made of the large development of the electric light, yet we are surprised to find that the exhibition has closed and no official recognition has been made of its great value and the assistance it has rendered towards assuring the success of the undertaking. It is not too much to say that the grand collection of paintings was rendered of increased value to the public by their being enabled to see it after dusk in consequence of the adoption throughout the galleries of the electric light. It is a matter of fact that had not these galleries been so lighted, they would have been closed, as the owners would not have allowed their valuable pictures to be viewed by means of any other artificial light. In the closing address of the Chairman of the Executive, we find that "in industrial design, engineering, and chemistry, we have endeavoured to represent the industries of our own city and the manufacturing towns which cluster around it," but nowhere in the address (although the Chairman was connected with the local electric light industry) is any mention of the very valuable assistance rendered by electricity.

The following facts with which we have been supplied, will serve to show how successful in every respect the exhibition has been. The aggregate attendance reaches the number of 4,765,137. This is a larger figure than was reached at any of the London exhibitions with the sole exception of the Colonial and Indian. The number of season ticket-holders was very close upon 40,000. With regard to the finances, we learn that the receipts have reached a total of no less than £250,000. This sum includes £23,000 contributed by the exhibitors, and no less than £40,000 from the refreshment contractor. The buildings cost £89,000, whilst the guarantors' fund amounted to £140,000. The weekly wages of executive staff, &c., amounted to £400.

The work of the removal of the exhibits commenced early on the Friday morning, and is now proceeding rapidly. The removal and packing of the pictures has been commenced this week; the short days would have rendered this a matter of time, but arrangements have been completed for carrying it on by means of arc lights. A Brush lamp has been placed in each gallery (14 in all) run from a Brush dynamo driven by a Robey portable engine. This arrangement has been fixed by the Anglo-American Brush Corporation at very short notice in the grounds just outside the galleries, and answers the purpose required.

On Friday evening, the 11th inst., the day after the closing of the exhibition, the staff connected with the electric lighting department met together to the number of about forty and dined at the Cornbrook Commercial Hotel, This number included the majority of the staff of the Anglo-American Brush and the Manchester Edison-Swan Electric Light Companies, the electrician's department of the exhibition, and the staff of the various firms who supplied the engines. Amongst the guests invited were Mr. Ashbury, Mr. Henry Bury, and the representative of this journal. The chair was occupied by Mr. W. A. Bryson, the electrician to the exhibition, who had kindly delayed his departure to Scotland in order to be present once again with his fellow workers. Mr. Court, the superintendent of the Anglo-American Brush Company (who had had charge of the arc light installation from the commencement) occupied the vice-chair, and successfully brushed away all crumbs of discomfort and helped his friends to pass a merry evening. Mr. R. Young, of the Edison Company (who had charge of the incandescent installation from the commencement), was present with the majority of his staff.

After the usual loyal toasts and the health of the "Guests" were drunk, Mr. Ashbury proposed in appropriate language the health of the Chairman, Mr. W. A. Bryson, and eulogised the services which he had rendered in his department. The toast was drunk enthusiastically, and Mr. Bryson received a perfect ovation, a remarkable expression of opinion of the esteem in which he was held by the officers and men who had worked under his orders. Mr. Bryson replied in feeling terms at the unexpected demonstration in his favour, and pointed out that but for the steady co-operation of all the work would not have been so steadily carried out. He was obliged for the assistance rendered by Messrs. Williamson and Parker of his own staff, and spoke most highly of the electric light contracting companies and the manner in which they had fulfilled their obligations. He also referred to some incidents of the lighting, and regretted that he was compelled to leave them for the north. The health of the vice-chairman was also proposed, and replied to in courtly and expressive terms. A merry and very successful, enjoyable evening was spent. It may be remarked that the dinner was of a private character amongst the staff themselves, and was not provided by the Executive of the Exhibition, a fact which may account for its great success and freedom from conventionality—being carried out thoroughly on the "square."

NOTES.

Electric Lighting in Paisley.—Messrs. Robertson and Co., electrical engineers, Paisley, have just completed the re-arranging and re-wiring of an installation of 150 lights for Messrs. Clark & Co., the large thread manufacturers, of that town. They have also recently completed an arc and incandescent installation for a dye-work in the same town. The incandescent portion of this latter installation was somewhat special, as the lamps had to be arranged so as to burn in a highly inflammable gas.

Lecture on Electric Lighting—Mr. W. B. Sisling, electric superintendent of the Newcastle Exhibition, delivered a lecture on the subject of electric lighting, at Newcastle recently. Messrs. Paris and Scott's transformers and Mr. Rowan's electric machine tools were exhibited and explained, and subsequently the lecturer gave it as his opinion that Newcastle, even with cheap gas, could be lighted as economically as at present, if electricity were used.

Rather Hard upon Him.—*La Lumière Electrique*, in its issue of November 5th, criticises the linguistic efforts of a certain patentee in the following manner:—"The inventor, it is needless to remark, is not a Frenchman. We do not know if the translator to whom the patent has been entrusted understands English; but we can positively assert that he is utterly ignorant of the French language."

Price of Arc Lighting in America.—The seven public electric lighting companies of New York have by competition brought down the price per arc lamp per hour from 7d. to figures ranging between 5d. and 2d.

Electric Lighting and Gas.—In the spinning factory of Messrs. Oudin & Co., at Dinant, the use of gas has been entirely abolished, the comparative cost of electric and gas lighting being as follows :—

Gas (preceding year).

360 jets of 123 litres, at 0·18 francs per cube metre, per hour, 7·97 francs.

	Francs.
857 hours at 7·97 francs	6820·30
Maintenance and sinking fund	600·
	7420·30

Electricity.

	Francs.
Carbons: Consumption per lamp hour, 0·044 francs; 36 lamps for 857 hours...	1357·50
Interest and sinking fund, 12 per cent. on 15,000 francs	1800·0
Maintenance and unforseen expenses	350·0
Coal: 18 horse-power at 1·5 kilos. for 857 hours, at 11 francs per ton	254·50
Additional coal for heating	110·0
	3872·0

There is consequently a balance in favour of the use of electricity of 3548·30 francs.

Storage Battery Lighting.—With reference to a *conversazione* of the Bournemouth Society of Natural Science, held at Ascham House on the 8th instant, the Bournemouth *Visitors' Directory*, of the 12th inst., says :—"Mr. Lynd fitted up twenty incandescent lamps, which were lighted by fourteen of the Electrical Power Storage Company's accumulators. These cells were charged at the Millwall Works and sent down from London for use at the *conversazione*. The light was brilliant and perfectly steady. The system of storage of electrical energy was explained to a number of gentlemen who appeared to take an interest in electric lighting, including two able commissioners of Bournemouth."

Electric Lighting at Leeds. — The Leeds Town Council has re-appointed its Electric Lighting Committee, but not without a show of opposition. One speaker, Mr. E. Wilson, observed that a sum of nearly £4,000 had been "squandered on a system of lighting which could have been got for half the money," while Mr. Alderman Emsley put the sum at £6,000. On the other hand, Mr. Alderman Fatham contended that there had been no waste of money. He admitted, however, that the Leed's installation could now be purchased for half the amount it originally cost. Experiments in electric lighting must be conducted by some one, says the *Gas World*, else the march of improvement must be arrested ; but is it the province of a corporation charging itself with the manufacture and supply of gas to a community to conduct such experiments ? We must answer the question in the negative. Looking to the interests of the ratepayers who are responsible for the payment of the amount sunk in gasworks, we are decidedly of opinion that the Corporation would have more faithfully performed its duty had it spent a few thousand pounds in discovering which of the improved lamps that have been submitted to the public recently is the best fitted to give the highest lighting power for the lowest consumption of gas. In this way the Council would have been advancing the interests of the industry of which it is the local guardian, and at the same time doing a great service to the community in general. It is a peculiar commentary on the Leeds Town Council, in its capacity as guardian of the gas undertaking, that it refuses on the one hand to purchase plant to insure the elimination of sulphur compounds from the gas, and on the other hand it spends from £4,000 to £6,000 on experiments in electric lighting.

Electric Lighting in Folkestone.—A public meeting was held at the Folkestone Town Hall on Monday to consider the desirability of lighting the town by electricity. Dr. Fitzgerald said, in a letter read to the meeting, that he thought the electric light might be supplied at a cost not exceeding the present cost of gas. The Lees could be lighted at an expense of £200. There was no question that the electric light would be a great advantage to the town. The chairman, Mr. W. J. Jeaffreason, thought the introduction of the electric light would not make much difference to the consumption of gas, and he was in favour of the town taking the matter in hand itself. Mr. Wharton, of the firm of Laing, Wharton & Down, advised the people of Folkestone to form a local company, and purchase arc and incandescent plant. Twelve arc lamps would light the Lees, and plant for those lamps would cost about £600 or £700. From the report which has reached us it does not appear that anything very definite was decided upon, although a number of speakers expressed themselves strongly in favour of introducing the electric light.

Electric Lighting of Theatres.—Says the *Bulletin International de l'Electricité:* The number of Parisian theatres illuminated with gas decreases slowly. The Edison Company has completed the installations at the Théâtre Français, the Menus Plaisirs, the Vaudeville, increased by a hundred the number of lamps at that of the Palais Royal, and reconstructed almost entirely the installation at the Eldorado. It is on the point of completing the lighting arrangements at the Gaité, and has begun to work at the Odéon and at Cluny. The installations at the Variétés and the Châtelet have been organised by the "l'Eclairage Electrique" company, which is also preparing the lighting at the Théâtre de Paris. That at the Renaissance has been constructed by the Rothschild-Geraldy-Deprez company, which is also about to inaugurate the lighting of the Théâtre de la Porte-Saint-Martin.

The Electric Light at the Theatre de la Monnaie, Brussels.—On the 16th ult. the electric light was formally installed in this theatre. There are 600 lamps in use varying from 8 to 30 candle-power with a difference of potential of 110 volts. The cables are coated with caoutchouc, asbestos and silicated cloth entirely inclosed in grooves, in silicated wood, and painted externally with asbestos. In the cellars is a battery of accumulators sufficient to give 6 hours of full light for the stages. The installation is particularly interesting because the machines which generate the current are at the distance of 4 kilometres from the theatre.

The Electric Lighting Dispute in Vienna.— The closing of the Vienna Opera House owing to the dispute between the lighting company and the municipal authorities, the correspondent of the *Daily Chronicle* says, has set all Vienna in commotion. The English company is naturally attacked, although it is difficult to see how they are to be blamed, inasmuch as it is the local authorities who have condemned the boilers and insisted upon their being placed under repair at the same time. The company, on the other hand, declares that this step was not at all necessary, as the boilers could have been easily replaced while under repair. The loss entailed is very great, as the company has to pay a penalty of 3,000 florins a night for any interruption of the lighting arrangements, and this is not the first time the penalty has been imposed, as on a former occasion they had to pay a total penalty of 32,000 florins. Pending the repair of the boilers it is probable that a temporary central station will be established, at the expense of the company. It is explained that the reason why the boilers became damaged is that the company, acting on the advice of the management of the Opera House, who wished to reduce the cost of the installation as much as possible, had the electric wires laid in the gas mains, and as this disturbed the insulation and reduced the current some 30 per cent., it was found necessary to considerably increase the boiler pressure. Unfortunately allowance had not been made for this, and the result was that the boilers cracked in several places. The Emperor is said to take the greatest interest in the question, and has ordered telegrams to be sent to him at Gödöllö, where he is staying, informing him how the matter is progressing.

Concessions for Electric Lighting in Paris.—The project for the authorisations to be granted to the different companies was submitted by the Administration of the City to the Municipal Council, requesting a prompt decision on account of the theatres. The council, however, postponed the decision, and in the meantime a number of theatres have solved the question by means of internal installations which do not require conductors to be laid under public streets. The projects of the following companies are under examination by the "Electrical Sub-committee" of the Municipal Council :—1. Paris Company for electric lighting in the quarter of the Pantheon. 2. Continental Edison Company. 3. Company for Electric Appliances and Lamps. 4. French Company for Electric Lighting. 5. M. Pulsford. 6. Marcel Deprez Company for the Electric Transmission of Power.

Proposed Telephone between London and Paris.—It is stated that observations are being made on the French coast and in the Channel, by French Government officials, with a view to laying down a new cable across the Channel for the purpose of establishing telephonic communication between London and Paris.

Adelaide Jubilee Exhibition.—Messrs. Robey and Co. of Lincoln have been awarded six first prizes at the Adelaide Exhibition for their horizontal automatic engine, compound portable engine, portable winding engine, wrought angle iron framed thrashing machine, patent Robey winding engine with wrought iron tank foundations, and centrifugal pumps.

Train Lighting in Germany.—A report has just been issued giving statistics of the different methods employed for lighting railway carriages in Germany. From this report it appears that gas is coming greatly into favour, and that oil is at present only used to a very limited extent. The circumstance that many of the railway companies have only recently fitted up gas plant for their trains at considerable expense operates to retard the introduction of the electric light.

International Exhibition Brussels, 1888.—Mr. S. Lee Bapty, so well known in connection with exhibitions in this country, has been appointed by the Executive Committee of the Brussels Exhibition Commissioner-General for the British Empire. He has secured for the purposes of the British Empire Section a space of 23,000 square yards, and has obtained the most favourable possible terms for exhibitors. Arrangements have been made with various railway companies for the free storage of all exhibits or glass cases, from the Royal Jubilee Exhibition, Manchester, which may be intended for Brussels. The charge for space is rather higher than is usual at English exhibitions, but is only about one-half the amount prevailing in the other sections of the Brussels Exhibition, and as the Government do not in any way subsidise the British Empire Section, it will furnish the only fund from which the cost of organisation, construction, decoration, attendance, &c., can be drawn. The classes include scientific instruments (7), lighting (17), metallurgy (21), India-rubber and gutta-percha (35), railways and tramways (38), and electricity (46).

The Royal Society.—At the meeting held yesterday (Thursday) a paper was announced to be read by Dr. J. Hopkinson, F.R.S., on "Specific Inductive Capacity."

Lighting of the Union Bank of London.—"Subscriber" writes : "Referring to the paragraph in your valued issue of November 11th, *re* Elwell-Parker plant being now installed at the Union Bank of London, it may open the eyes of many of your readers when they are informed that the consulting electricians are the sole London agents for that above-mentioned firm of manufacturers. Further comment is needless. Will any of your readers think it worth while to express an opinion ?"

The Treatment of Secondary Batteries.—Sir D. Salomon's little work on "Accumulators" has passed through two editions rapidly, which proves that it is much appreciated as a practical handbook. Messrs. Whittaker are now announcing a third edition, with many illustrations in the text, which will be ready shortly.

Electrical Tramways in Vienna.—The Tramway Company of Vienna is in treaty with an American association for the adoption of electric instead of horse motive power on its systems. The change will be made so soon as the authorities grant the necessary permission.

The Submarine Telegraph Company.—We learn that the Chambers of Commerce of Havre, Paris, Bordeaux, Rheims, and other towns are protesting against the action of the French Government in renewing the Submarine Telegraph Company's monopoly.

The Extended Electro-Metal Extracting, Refining and Plating Company.—Under this title a company is about to be formed to carry on upon a larger scale the business commenced early in 1886 under a similar name with the exception of the word "extended." In our issue of June 25th, 1886, in calling attention to the formation of that company, we expressed our good wishes for its success, and it is with pleasure that we now hear from the managing director, Mr. Thomas Fenwick, that the processes carried on at the works have proved so satisfactory that the original shareholders have, without exception, shown their confidence in the future outlook by accepting shares in the new company to the full extent of their interest in the expiring one, and in many cases they have doubled their holdings. The scope of the company's operations includes the recovery of pure tin from waste cuttings, the treatment of the heaps of refuse in the locality of mines, in which the percentages of precious metals is so small that they cannot be extracted remuneratively by any other means, and also re-depositing metals so obtained by a so-called electro-galvanising process. Iron articles coated with tin by this process, though rather dull in appearance compared with ordinary galvanised goods, are preferable in some respects, and can be sold at lower prices. On the formation of the new company the present premises will be extended and the engine power and electrical plant largely increased. It is also in contemplation to start branch works in five localities, some being places where the raw material is at hand in quantity, and others being the best centres in which to carry on the plating departments of the business. The capital of the new company is to be £150,000 in shares of £1.

The Society of Telegraph-Engineers and Electricians.—At the meeting to be held next Thursday, November 24th, the following papers will be read :—1. "On some instruments for the measurement of electromotive force and electrical power," by Dr. J. A. Fleming, M.A., member, and C. H. Gimingham ; 2. "Portable voltmeters for measuring alternating potential differences," by Profs. W. E. Ayrton, F.R.S., V.P., and John Perry, F.R.S., member.

Balloon Signalling.—We notice in the last issue of *Nature* an account of the recent electric balloon signalling experiments carried out on the evening of October 26th, at Berchem in the fortifications outside Antwerp. The method employed is that of Mr. Eric Bruce. The balloon was a small one, only 15 feet in diameter, and inflated with very dense coal gas, although originally designed for hydrogen. It lifted 500 feet of electric cable besides the captive rope. There were six lights in the balloon, giving about 20 candle-power each. It seems that the night was an excellent one for signalling, and the experiments were completely successful. The observing stations were placed on the existing telephone circuits, only 4 or 5 kilometres distant, but the balloon is stated to have been seen to an enormous distance.

Liepmann's Primary Battery.—It is quite refreshing to meet with an inventor who has not a ridiculously exalted notion of the capabilities and the value of his invention. The plain, candid speech of Dr. Liepmann last week is a lesson in honesty and modesty to those bounceable gentlemen who have recently striven to pose as men of tremendous genius—electrical stars of the first magnitude, in fact. Dr. Liepmann said: "Among the articles which we manufacture, the primary battery for lighting purposes has no doubt a very large field. We are aware, however, of the confines of our territory, and we propose to devote ourselves to the cultivation of the soil within it. We make no pretensions of encroaching on domains where it would be beyond the power of any primary battery to compete with electric currents generated by dynamic means. Every now and again the extraordinary performances of some new combination are trumpeted forth, but to the initiated these carry their own condemnation, as they profess to do that which it is not within the province of any primary battery to achieve. We make no such ludicrous pretensions. We are not manufacturers of miracles, but we think we have worked out an apparatus which will within its own sphere efficiently comply with the demands that can be legitimately put upon it. In inviting you, gentlemen, to inspect our works, we ran to a certain extent the risk of seriously disillusionising you as to anything of magnificence in our operations, for, after all, these are not complicated, and are based on simple chemical and electrical principles. If it be true that the unknown is the magnificent, and we can no longer fairly sustain that idea, I hope and believe, on the other hand, we have shown that we are pursuing an industry of increasing practical utility, an industry the articles of which can only hope to hold their own by virtue of their inherent goodness, and an industry which it will be our pride and care to foster with all the means and energy we can command."

Club Lighting. — The Isthmian Club, we are informed, was not fitted up by Messrs. Woodhouse and Rawson, as stated last week. The brass fittings used in the billiard room and in some of the passages were supplied and fitted up by Messrs Verity and Son, but the fittings for by far the greater number of lights, which are constructed altogether of wrought iron and are exceedingly handsome, were made by Messrs. Starkie, Gardner & Co., and installed by Messrs. Manville and Madgen.

Fire Alarm Bells.—The tender of Messrs. Jolin and Co., of Bristol, was accepted for the fitting up of electric fire alarm bells at the Stapleton Workhouse.

Personal.—Mr. Robert Garrett, of telegraph and cable fame, has resigned the presidency of the Baltimore and Ohio Railroad Company.

Liepmann Carbon Company.—It is understood that an issue of shares in the Liepmann Carbon Company will shortly be offered to the public.

Removal.—Messrs. E. L. Berry & Co. have removed to more convenient premises at 8, Wardour Street, W.

Miners' Safety Lamps.—In the second part of his paper on "Accidents in Mines," read before the Institution of Civil Engineers on Tuesday, Sir Frederic Abel gave an account of the great progress which had been made within the last two years towards providing the miner with a thoroughly portable, self-contained electric lamp. Extensive trials of the Swan lamps, as manufactured by the Edison-Swan Company, had already established their efficiency underground, and primary battery lamps, of the Schanschieff type, and, perhaps, of others, seemed likely to enter into a serious competition with them, in regard to size, weight, illuminating power, and cost. The latter item appeared at present the most serious obstacle to the extensive use of electric lamps by the miner.

Our Opinion.—We have for several weeks past been using daily the instruments of the New Telephone Company which were courteously placed at our disposal. They have so far given us no cause for complaint, and if all the customers of the company are supplied with equally good telephones they should be well content.

The Electro-Harmonic Society.—Members are reminded that the "Ladies' Night" is fixed for December 2nd, and that extra tickets can only be obtained on application to the Hon. Secretary. A most excellent programme has been provided, and a very enjoyable concert may be anticipated.

The Consolidated Telephone Construction and Maintenance Company, Limited.—We understand that notice has been given to terminate the connection hitherto existing between the company and Mr. George Alanson Mason (late of the American Telephone Company).

Electric Lighting in Brussels.—The Société Industrielle, for the electric light installation in the new military hospital at Brussels, will employ two Naeyer boilers, two 40-H.P. Walschaerts engines, and two dynamos, each to supply 500 lamps. The arrangement allows of the dynamos being used either together or separately, and of the employment of several arc lights, should these be required. The dynamos are being specially designed for this work with ample margin of output. Some Cingalese who are giving a panorama in the Boulevard de Hainaut have marked their appreciation of modern progress and Western civilisation by employing the electric light. The Société Industrielle has installed there two arc lamps which are fed from a battery of Gadot accumulators, which is daily taken to the society's works to be charged.

The Electric Light in Hamburg. — The Senate of Hamburg has proposed to the corporation of that city that a sum of one million marks (£50,000), be granted for the making of experiments with the electric light in the principal thoroughfares of the city, provisionally along the Jungfernstieg and in the vicinity of Binenalster. The corporation prefers however to draw the royalties from the private electric light companies and is not anxious to have any competitor for lighting the city as its gasworks at present yield an annual profit of about three million marks (£150,000). The number of electric light companies in the city has now risen to 20, possessing 10,000 glow lamps. The corporation has, in consequence of the vote of the Senate, appointed a committee to consider the proposal, which recommends granting the sum in question, and the establishment of a central electric lighting station. That no step of this nature has been taken before in such a wealthy city as Hamburg is due to the circumstance that electro-technical science is considered not yet to have reached any degree of perfection and that fresh discoveries are constantly being made. However, under recent experiments the light has met with general approval and hence the decision referred to above.

The Telephone in the River Plate. — A new telephone company at Buenos Ayres, says *Industries*, has ordered from the Paris General Telephone Society the necessary material for a system comprising 2,000 subscribers, about to be established in that town. The same company has in hand a scheme for connecting the town with the outer harbour, by means of a telephone line. It is proposed to erect a small iron tower in the middle of the river, to serve as a maritime station.

Telephone to St. Bernard.—The monks of St. Bernard have established what is probably the highest-lying telephone connection in Europe, in order to facilitate their famous work of charity. Their well known *hospice* is thus now in telephonic communication with the towns of Proz and St. Pierre in Switzerland and those of Fontine and St. Remy, on the Italian side of the mountain.

NEW COMPANY REGISTERED.

Railway Train Telegraphy Company, Limited.—Capital £3,000 in £1 shares. Objects: To construct demonstrative lines of railway train telegraphs with all necessary adjuncts, under letters patent granted Thos. A. Edison, Ezra T. Gilliland and Lucius J. Phelps. Signatories (with one share each): W. H. Wood, 42, Gutter Lane, E.C.; A. Dix Philps, 4, Somerset Villas, Wimbledon; R. Ponsonby Staples, Hornton Street, Kensington; C. Schmolle, 111, Tuffnell Park Road, N.; W. J. Rose, 64, Riversdale Road, Highbury New Park, N.; R. L. Lomax, 51, Westbourne Street, Chelsea; C. Crisp, 13, Poplars Avenue, Willesden Park. Registered 11th inst., without articles of association, by J. R. Shearer, Etor Lodge, Albion Road, Stoke Newington.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Australasian Electric Light, Power and Storage Company, Limited.—The annual return of this company made up to the 31st ult., was filed on the 11th inst. The nominal capital is £324,026 divided into 50,000 original shares and 1,000 founders' shares of £5 each, 34,513 ordinary and 34,513 deferred shares of £1 each. Upon 23,985 shares £4 10s. per share has been called, the calls paid amounting to £106,301, and unpaid to £1,631 10s. Upon 15 shares forfeited, £60 has been paid. Upon 1,000 founders' shares, 6,000 original shares, 34,308 ordinary shares and 34,308 deferred shares, the sum of £103,616 is considered as paid up.

Engine Company, Limited.—An agreement dated 2nd inst., provides for the purchase from Arthur George Brown, of the right to manufacture and sell Westinghouse engines which Messrs. Alley and MacLellan are now entitled to, together with several letters patent and all the Westinghouse engines in course of manufacture by the said firm at the Sentinel Works, Polmadie, Glasgow. The purchase consideration is £35,000, payable £10,000 in cash, and the balance in fully paid shares. Registered office, 15, Holborn Viaduct.

CITY NOTES, REPORTS, MEETINGS, &c.

West India and Panama Telegraph Company, Limited.

THE twenty-fourth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Wednesday, under the presidency of Mr. C. W. Earle, chairman of the company.

Mr. R. T. Brown, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, and a payment of 9s. per share, said the period embraced by the report was not the least prosperous they had had to submit to the shareholders. That period had been marked by events of considerable interest to the board, arising from matters outside the regular duties of the company. The first was the long depression in the West India sugar trade. That depression affected them indirectly—first, by curtailing traffic, and, secondly, by inducing the colonies to draw their pursestrings, in the matter of subsidies, a little tighter than they would if they were more prosperous. Those who were interested in the great staple trade of the West Indies attributed the extraordinary fall in the price of sugar of 50 per cent. to the action of the sugar bounties which were paid by foreign Governments for the production of beetroot sugar in their respective countries. Those bounties amounted to £7,000,000 a year, and their effect was to place the beet sugar of France, Germany, and other countries on the English market at prices below what it would cost to produce but for the bounties, and the result was, of course, very damaging to the West Indian interest. He was happy, however, to say that a conference upon the subject of these bounties was to be held in London on the the 24th inst., and it was probable something might be settled to modify the effect of this arrangement of foreign Governments. The other cause of anxiety during the half-year was the proposal of the French Government to guarantee £40,000 a year to a cable between Martinique and Guadaloupe. The bill was presented to the French Chamber by the Minister of Posts and Telegraphs with all the power he could bring to bear. The subject was debated at length in the French Chamber, but was eventually rejected. They were able to report the repair of a very important link of their cable between Jamaica and Porto Rico, which, though broken on the reconstruction of the company in 1874, was repaired only in 1885, when it failed in 2,400 fathoms of water, where it could not be raised. They had been obliged, therefore, to go a considerable distance on each side the break into shallower water, and repair it by laying on 439 miles of new cable at a cost of £51,000, so that, as the whole cable was only 700 miles long, two-thirds of it were now new. While the report was in the press they had been advised of a break in the Colon cable 36 knots from the coast, but a ship was on the coast, and as the water was shallow they expected to hear every moment that the repair had been effected. But for that they would have been able to report all their cables in working order. The Chairman then referred to letters received from two shareholders suggesting the raising of debenture stock in order to satisfy the prior claim which the first preference had on what were unearned dividends, and said that he was advised that would be *ultra vires*, that it would be liable to be stopped at any moment, and that the directors might be held personally liable for any damage which anyone might claim against them. Another proposal was to pay off that prior claim out of the reserve fund, but that the board were determined not to do, as the reserve fund was the keystone of the whole concern, representing the depreciation of 4,000 miles of cable, some of which had been 17 years in the water. The amount of the reserve fund was not a bit too much for the security of the whole enterprise, and the board would not be parties to dipping into it to pay dividends which had not been earned. He concluded by formally moving the adoption of the report.

Mr. William Ford seconded the resolution.

Mr. William Abbott submitted a scheme for placing the finances of the company on a more satisfactory footing. His proposal was to cancel the £38,019 of dividend overdue on the first preference shares by an issue of an equal amount of first preference capital; and to cancel the second preference capital and the accrued dividends thereon by an issue of first preference shares in the proportion of 75 per cent., or £7 10s. a share in exchange for each £10 second preference share and the dividends overdue thereon. The preference capital would then amount to £418,666 and the ordinary capital to £883,210, making together a total of £1,301,876, or a decrease of £32,683 compared with the present capital and overdue dividends. He maintained that by his scheme there would be an immediate increase of 15s. a share in the market value of the preference shares, and that the ordinary shares would be immediately brought within range of a dividend. On the basis of the dividends paid for the past year, it would take over seven years to liquidate the amount now overdue on the first preference capital.

Mr. Morten thought Mr. Abbott's scheme a very good one and one which would work well. Its only failing was that it did not treat the second preference shareholders quite fairly enough. For the past 7¼ years, during which the second preference shareholders had received no interest, the board had taken too pessimistic a view of the affairs of the company, hence the low price at which the securities stood at the present day. Mr. Abbott's scheme had his sympathy, and, no matter what the board might say, it was one which, under the articles of association, might be adopted.

The Solicitor intimated that although the scheme might be a very satisfactory and equitable one, it could not be carried into effect without either the unanimous consent of the shareholders or an Act of Parliament.

A slight discussion ensued, in which it appeared that Mr. Abbott's scheme met with general favour amongst the shareholders. Eventually,

Mr. Abbott said he thought he had sprung the scheme somewhat suddenly upon the board, and therefore it might be wise to allow the matter to be discussed by the directors in the board room, they (the directors) being empowered to call in himself and his clients if they thought proper. With a few alterations and modifications, he thought it would be found that the scheme was a workable one, and would meet with the approbation of the general body of the shareholders.

The Chairman said he and his colleagues would be only too glad to accede to that course, and he would pledge himself that they would give the matter immediate consideration.

The subject then dropped, a vote of thanks was accorded the chairman and directors, and the meeting terminated.

The Pilsen-Joel and General Electric Light Company, Limited.

THE sixth ordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, on Thursday last week, Sir Rawson W. Rawson, K.C.M.G., C.B., presiding.

Mr. W. H. Trentham, the Secretary, having read the notice convening the meeting, the directors' report, which was published in the REVIEW last week, was taken as read.

The Chairman thereupon moved its adoption. He said: Our object to-day is mainly to sanction the dividend which the board are able to propose to you. That dividend is but a small one. We had hoped that it might have been at least equal to that of the preceding year, but the circumstances of the last year have not been favourable for electric lighting generally, either with ourselves or with other companies. Our object, as you know, from the beginning has been to carry on our business with the capital that was left to us without calling upon our shareholders to

increase it. Our capital, as is shown in the report, is but a very small one—not exceeding £7,000—and we have been desirous of entering upon no speculative business of uncertain return which should diminish that small capital. We see, like other companies, a future for electric lighting; but until some Bill passes the Legislature there can be no large development of the distribution of electricity for lighting purposes. At the present time it seems rather that people are desirous of receiving electricity as they do gas, and that the prospect of profitable investment of our capital is in the way of installations. We have, therefore, since our last meeting, formed a new installation at the head of Tottenham Court Road, which, we feel assured, will be a profitable investment and will increase in profit. We have removed our offices from the small building and factory in which they were placed to other premises in Stanhope Street, where there are means of developing our business to a very considerable and safe extent. We have already had a profitable return for our investment there, and have the prospect amongst the surrounding tradesmen of increasing our profit from that installation considerably. It is very satisfactory that Mr. Baker, who was our original customer in Holborn, has shown that he was so far satisfied with his installation there that he has extended it to another of his establishments. In the same way at Holborn we have increased our means of obtaining customers there by putting in a more powerful engine, which will enable us to run our circuit into Fleet Street and elsewhere, and there we find another proof of the satisfaction that we are now able to give to our customers, inasmuch as Mr. Baker has entered into a contract to extend the lighting to his establishment in Fleet Street. In the same way other large customers in Tottenham Court Road and Fleet Street have contracted to light their establishments. We therefore see for the future the probability—I may say the certainty—of increasing considerably our annual profits, and being able to distribute a larger dividend in future years. But, at the same time, as has been already remarked, our capital is very small, and, as you know, in order to obtain an annual profit from our installations, we must invest a considerable amount of money in the installations themselves, and we therefore feel ourselves at present limited in our operations by the amount of our capital. Your attention has been called in the report to that point, and to another in our affairs, namely, the shares that have been forfeited. I do not know that I have anything else to call your attention to, but I may wind up by expressing our feeling of confidence with regard to the safe and profitable working of the company with its present small capital; and if electric lighting shall become more popular, and there shall be evidence of a desire on the part of persons to avail themselves of it, and we can see our way to a profitable extension of our business, it will be our duty to avail ourselves of every means now at our disposal to extend our business safely, and if those means are not sufficient to call your attention at the next meeting to the circumstances, and to invite your opinion as to the advisability of taking some steps to increase our scope of obtaining a larger profit for our shareholders.

Mr. Ross: May I ask what is the cost of the new installation at Tottenham Court Road?

The Chairman: About £1,200.

A Shareholder: And I suppose the money invested in consols is available for that purpose?

The Chairman: Certainly. You will understand that it will be very much more profitable to us to use our consols than to leave the money lying there at 3 per cent. or less. Therefore you may count upon our using that as far as we safely can. We must of course always have a certain reserve to meet contingencies, to meet the opportunity of entering upon some larger enterprise.

Mr. Ross: Was all the money for the Holborn station taken from consols. No part of the revenue has been used for that purpose?

The Chairman: It has been taken from our current funds. The best answer to that is to tell you what was the amount of our consols at the last meeting and what it is now. Last year the sum invested in consols on June 30th was £3,500, and on June 30th, 1887, it was £2,986—a diminution of a little over £500. That amount has been diminished since, and the cost of the engine at Holborn will have to be met out of the consols.

Mr. Ross: The difference has been taken from revenue, I presume?

The Chairman: Yes, from revenue. It has been diminished since, and the cost of the engine in Holborn will have to be met out of the consols.

Major Scriven: We consider all that as working capital. It is all in the £7,000 that the chairman told you was our working capital.

The Chairman then put the motion: "That the report of the directors, dated November 10th, 1887, together with the accounts and balance sheet for the year ending June 30th, be received and adopted."

Major Scriven seconded the motion, which was unanimously carried.

Mr. George Levinge Whatley, having been re-elected a director of the company, said he saw no reason why they should not get back a good deal of the money which was lost in the early days of the company. Electric lighting was progressing, and they would soon, he thought, witness an extension of the lighting of private houses. All that was wanted was a little energy and a little money for the purpose of development.

Messrs. Broom, Hays and Akers were re-appointed auditors, and the meeting terminated with a vote of thanks to the chairman.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 11th were £3,651, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended November 12th amounted to £4,609.

NEW PATENTS—1887.

14996. "Gear for transmitting motion from electric motors to driving axles of vehicles." E. HOPKINSON. Dated November 3.

15006. "Electric switch." R. BUTCHER, E. ROUSSEAU. Dated November 3.

15056. "Multiple electric cable." J. A. BETTS. Dated November 4.

15063. "Galvanic batteries." D. SKRIVANOW. Dated November 4.

15084. "Taking up the slack in wires used for transmitting electric currents." W. H. STURGE. Dated November 5.

15095. "Electro-dynamic apparatus for controlling motion." S. EVERSHED, W. T. GOOLDEN. Dated November 5.

15099. "Transmitting and receiving apparatus for type-printing telegraphs." A. LE. N. FOSTER, W. S. STELJES. Dated November 5. (*Complete.*)

15117. "Electric motor." J. M. V. MONEY-KENT, S. SHARP. Dated November 5.

15118. "Incandescent lamps." W. CLARKE, C. A. PARSONS. Dated November 5.

15136. "Electric torch for lighting fires, lamps, &c." S. S. BROMHEAD. Dated November 7.

15141. "Galvanic batteries." A. F. ST. GEORGE, C. R. BONNE. Dated November 7.

15158. "Electric safety lamps." J. SINCLAIR, J. P. REES. Dated November 7.

15161. "Coin-freed electrical apparatus." P. EVERITT. Dated November 7.

15176. "Galvanometer." M. IMMISCH. Dated November 8.

15217. "Measuring alternating currents of electricity." W. LOWRIE and OTHERS. Dated November 8.

15232. "Recording and reproduction of spoken words and other sounds." E. BERLINER. Dated November 8. (*Complete.*)

15259. "Voltaic batteries." T. J. JONES. Dated November 8.

15299. "Meters for measuring electricity." E. PERRETT. Dated November 9.

15321. "Electrical storage batteries." J. PITKIN. Dated November 9.

15328. "Galvanic batteries." A. SCHANSCHIEFF. Dated November 9.

15329. "Covering insulated electrical conductors with lead, &c." R. W. EDDISON. (Communicated by E. McKnight.) Dated November 9. (*Complete.*)

15385. "Disinfecting impure liquids by electrolytic action." E. HERMITE. Dated November 10.

15392. "Primary batteries." H. J. HADDAN. (Communicated by B. Scheithauer.) Dated November 10.

15445. "Electrically controlling the speed of steam engines." E. JONES. Dated November 11.

15448. "Preparing spongy lead for use in secondary batteries or accumulators." G. TEIER. (Communicated by E. Fischer.) Dated November 11.

15455. "Connecting a number of separate electrical conductors to one main conductor." W. S. ROGERS. Dated November 11.

15484. "Safety devices for use in connection with electrical circuits." P. CARDEW. Dated November 12.

15498. "Combined shutter switch and shield for electric incandescent and other lamps." J. GALE. Dated November 12.

15532. "Electric explosives." S. JOYCE. Dated November 14.

15537. "Electric switches." R. W. PAUL. Dated November 14.

15555. "Applying electric motors for charging secondary batteries." W. M. MORDEY. Dated November 14.

15588. "Dynamo-electric machines." J. Y. JOHNSON. (Communicated by W. C. Rechniewski.) Dated November 14. (*Complete.*)

15642. "Regulating the electromotive force of secondary circuits." W. H. SCOTT, E. A. PARIS. Dated November 15.

15653. "Electric signalling apparatus for trains." H. H. LAKE. (Communicated by the De Mier Electrical Signalling Company.) Dated November 15. (*Complete.*)

15660. "Electric clocks." A. J. THOMAS. Dated November 15.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Tuesday, November 10th, Sir CHARLES BRIGHT, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed and the list of proposed new members announced, a paper was read by Mr. EDWARD STALLIBRASS, F.R.G.S., Member, on "Deep Sea Sounding in connection with Submarine Telegraphy." Mr. Stallibrass said the history of deep sea sounding might almost be said to date from the time of the first Atlantic Cable scheme in 1858. Although the importance of soundings at frequent intervals over a cable route was well recognised as early as 1858, proper attention had not been given to this important item until recently. When the first Red Sea Cable was laid, practically no soundings of the route existed, and it was afterwards found that depths of 2,000 fathoms existed when the cable was only designed for a depth of 1,000 fathoms. The Channel Island Cable failed from proper soundings not having been taken. In the Atlantic six unexpected banks had been found, and the *Faraday* when laying one of the Atlantic cables, had found a large quantity of volcanic rock amongst the ooze in the sea bed. In plotting out the results of soundings, these should be done on a uniform scale both for the ordinates and abscissæ, otherwise the diagrams would be very misleading. As a result of the numerous soundings made by the Silvertown Company, a recent cable of 2,300 miles, made and laid by them, had 17 different types of cable designed to meet the different requirements of the different depths, &c., of water. The quality of a cable was now no longer a matter of difficulty, the chief point was the proper laying. The first attempts at deep sea soundings were made by Hook in the 17th century. His apparatus consisted of a piece of wood attached to a sinker, the wood being detached when the sinker reached the bottom; this system was, however, faulty and unreliable unless used in shallow water. In 1845 some extensive surveys of the sea bottom were made by the United States navy. In 1848, iron wire was used for the sounding line, but not with success. In 1874, Sir William Thomson read a paper before the Society describing his system of sounding with pianoforte wire; this system had been very generally adopted. In many cases where soundings had been taken close together, sudden dips and rises had been found which would not have been noticed if the soundings had been taken further apart. In recent expeditions the Silvertown Company had taken between Cadiz and Teneriffe alone, a distance of about 700 miles, 673 soundings, on one expedition, resulting in the discovery of two banks, two coral patches, and four other shoal spots. Some of the inclines near these banks were remarkable for their steepness. On the east side of one of these the bottom fell precipitously for 450 feet; and on a sounding taken by the *Dacia* during her survey of the Seine bank, a precipice of 1,800 feet was found. A map of the mouth of the Congo showed a most remarkable submarine gully, the contour lines of which were drawn from 202 soundings, many of these having been taken at intervals of less than one mile. In the mouth of this remarkable river a depth of no less than 1,452 feet was found, the Thames in a similar locality giving only about 40 feet. The gully was distinctly traced 100 miles out at sea. He predicted that far more attention would in future be paid to the way in which cables are laid than to details of their manufacture, which was now practically understood, and their lasting powers would no doubt be greatly increased thereby. It seemed almost incredible that probably one-half of the cables now lying at the bottom of the ocean, amounting to a value represented by several millions sterling, had been placed on their ocean bed while those carrying out the work were almost totally ignorant of the bottom on which the cables were destined to lie. The only excuse for this seemed to have been the inefficiency of the sounding apparatus at the time these cables were laid, an excuse which no longer existed. Mr. Stallibrass then explained the construction of forms of sinkers that had been employed, including one designed by himself which contained important improvements. As regards the sounding line, steel was greatly superior to hemp, and this was now universally admitted. Steel possessed a high breaking strain and a smooth surface, and the moment when the sinker struck the bottom was easily detected. Wire could be used when the ship was moving, which was not the case with hemp. A sounding of 1,000 fathoms could be taken in 18 minutes 15 seconds, and one of 2,000 fathoms in 37 minutes 45 seconds. The importance of examining the ocean bed would be seen from the fact that isolated patches of bottom with mineral deposits were often found; these deposits would act prejudicially on the sheathing of the cable, causing it to decay. It was advisable to take temperatures where possible, as such observations assisted in determining the configuration of the sea bed.

In the discussion which followed the reading of the paper, Captain WHARTON stated that all the ships in the Navy were fitted with sounding apparatus and soundings were continually being taken. Galvanised iron wire had been used with good results; such wire did not require to be kept in a preservative solution.

Mr. BUCHANAN said that it was very important that the steel sounding wire be fingered as little as possible; if proper care is taken, the wire will last for a very long time. The use of a hemp sounding line had the advantage that it enabled the sinker to be recovered. Cables ought to lie in mud; where no mud existed it meant that there was some disturbing cause which prevented the mud from accumulating, which cause might be prejudicial to the cables. Shallow water was good in some respects, as it meant the absence of marine animals.

Mr. CHARLES BRIGHT, jun., said that although an accurate knowledge of the configuration of the sea bottom was most desirable, yet the question of the time and expense involved by taking the soundings required to be considered. In 1860, Mr. W. H. Preece, in a paper before the Institution of Civil Engineers, had insisted upon the necessity of an accurate survey of the bottom being made, but the idea was scouted at the time. The cost of manufacture and laying of a cable was so heavy that any additional expense in the way of making an extensive survey of the route, required to be taken into account. Even if the soundings were taken at distances of two miles only, the element of chance came in, as it was quite possible that a gully or bank might exist between two mile spaces, as was indeed shown by the author of the paper in the case of the *Dacia* bank. Of course every additional sounding increased the chance of avoiding mishaps, but it also increased the expense of the whole work. The chances of an irregular bottom were much greater in the vicinity of islands, and therefore extensive soundings in such cases would have greater justification. In citing the Lisbon-Madrid cable mishap it should also be recollected that a very large mileage indeed of cables had been laid and the cables had had protracted lives in cases where but very few preliminary soundings had been taken. Those who might be inclined to condemn the early pioneers of submarine telegraphy for having done their work without sufficient surveys, should recollect that it was only comparatively recently that a good system of sounding, by wire, had been introduced. If soundings were taken at all, they ought to be taken at as early a stage as possible, so that a knowledge of the exact nature of the bottom might be obtained previous to the cable being designed; unfortunately, however, the contract often necessitated the work being hurried through as quickly as possible. He thought the statement that shallow-water cables should never be laid, required qualifying, as this would seem to imply the deeper the water the better, which could not of course be the case; 500 fathoms (as the author said), was, perhaps, the most favourable depth. When specimens were obtained from the sea bottom, it was absolutely necessary that they be examined on the spot, for if they were kept for any time exposed they would so alter their character as to give a false impression when examined.

The meeting then adjourned.

Physical Society, November 12th, 1887.

Prof. W. E. AYRTON, F.R.S., Vice-President, in the Chair.

LIEUT. BARON, R.N., was elected a member of the society.

Owing to the illness of Dr. Shettle, the paper announced to be read by him was postponed.

The following communication was read: "On a Geometrical Method of Determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents," by Mr. T. H. BLAKESLEY, M.A.

In this paper the author confines himself to the consideration of a simple circuit containing generating, conveying and recipient parts, in which the E.M.F. follows the law of sines.

The maximum E.M.F. of both machines are supposed known, together with the resistance and coefficient of self-induction of the complete circuit.

The variable on which the efficiency of transmission depends is the difference of phase of generator and receiver. A geometrical construction is given by which the phase which gives the maximum efficiency can be determined.

Mr. KAPP thought the construction would not apply where the receiver did mechanical work, owing to the E.M.F. not being a true sine function of the time. He also mentioned an experiment performed on a motor driven successively by alternating and direct currents, in which the *apparent* power $(\sqrt{c^2}\ \sqrt{c^2})$ supplied by alternating currents was about five times that required when direct currents were used, the motor giving out the same power in the two cases. From this he inferred that the ratio of power to weight was much greater for a direct than for an alternating current motor. This he considered a serious drawback to the use of alternate currents for transmitting power.

After some remarks by Prof. AYRTON and Prof. S. P. THOMPSON,

Mr. BLAKESLEY said that by placing a condenser between the terminals of the recipient machine a greater current could be passed through the receiver than that in the generator and line.

CORRESPONDENCE.

The Carbon Transmitter.

I desire to use the REVIEW to make known a few facts, which are of great importance now and will be of much greater importance in the future, regarding the use in the United States of *carbon* in a microphonic transmitter in combination with a diaphragm or tympan.

On April 14th, 1877, Emile Berliner filed a caveat in the Patent Office for a transmitter in which carbon with

a tympan was used. What the precise claim is I do not know, but I have been informed by Mr. Berliner that "this subject-matter is covered by the pending application which is still in interference with Edison."

The above is all the information I have about Berliner's caveat of 14th April, 1877. On July 20th, 1877, Edison made application for a patent in which the third claim reads as follows :—"In a telegraph apparatus operated by sound the combination with the diaphragm of one or more contact points of plumbago or similar inferior conductor in the electric circuit, whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm."

This claim was declared by the Patent Office to be in interference with the caveat of Berliner.

Two patents were issued to Edison upon his application filed on 20th July, 1877, but there is *not* in either of them a specific claim to the use of carbon, although carbon is named in the specifications as being preferable.

Berliner also obtained patents in which carbon is named, but in none of them is there a specific claim for carbon, because the interferences respecting the claim to the use of carbon in a transmitter between Berliner and Edison had not been decided, and what is of the greatest importance is that it has *not yet* been decided although the interference dates from July, 1877.

The case as to the use in the United States of carbon with a tympan in a transmitter stands there. There are two claimants, viz., Berliner and Edison, to the use of carbon as filed in the Patent Office in 1877. The American Bell Telephone Company long ago acquired *all* the telephone inventions of Berliner and Edison. That company therefore owns the claims to the use of carbon with a tympan, and can, whenever it may seem to be for the advantage of that company, amicably arrange the interferences and obtain a patent which will cover the use of carbon with a tympan in a transmitter, and the patent will bear date from the day of its issue.

I believe that it is generally admitted that there is no efficient microphone unless with one or more carbon contacts and a tympan.

In order to extend the monopoly now secured to the American Bell Telephone Company beyond the date of the expiration of the Bell patents in 1893, that company can, under the applications of Berliner and of Edison of 1877, obtain a patent just before the date of the expiration of Bell's patent and under that carbon transmitter patent, the control of telephony in the United States will remain with the Bell Company for 17 years more.

The managers and counsel of that company know well their business. Even if Bell's patent of 1876 were to be annulled, that could not materially affect the American Bell Telephone Company, as their carbon microphone would control telephony here.

In view of this state of facts about the carbon microphone I do not consider Bell's patent of any value. All he has is a receiver having "a permanent magnet with an iron tympan," and I have shown in the REVIEW that there are many receivers better than Bell's, and entirely apartfrom the patent, notably the Bourseul receiver of 1856. There is no doubt that all carbon transmitters made prior to the issue of the carbon patent hereafter can be used here, but after the issue of that patent, the manufacture, use and sale will be illegal.

The facts about the claim to the use of carbon in a telephone or transmitter are now for the *first time* made public, and will fall like a bombshell among the numerous inventors of carbon microphones, who are looking forward to the expiration of Bell's patent.

I will conclude by advising inventors to make carbon microphones *without* a tympan or diaphragm.

I send this statement to the REVIEW because I think it will be read by a greater number of interested persons both in England and in the United States than if I published it in any of the scientific (!) publications here.

W. C. Barney.

New York, *November 4th*, 1887.

The Lever Dynamo.

We notice in your issue of the 4th inst. a letter from Mr. Lever comparing the performance of a dynamo recently designed by him with the work done by one of ours constructed two years ago. Mr. Lever gives the output of the "Phœnix" machine as 2,400 watts at 1,600 revolutions per minute, but these figures are quite erroneous. The series dynamos sent out by us having the carcase dimensions given by your correspondent produce 8,000, 6,400, and 5,500 watts respectively at 1,400, 1,200, and 1,600 revolutions. The mistake made by Mr. Lever may be pardoned, however, in consideration of the sound sense he displays in taking the "Phœnix" dynamo as his model.

Paterson & Cooper.
W. B. E.

Action of Oils on Metals.

In connection with my letters upon underground wires, in which the action of oils upon metals is incidentally referred to, I would ask you to grant me space for an extract from the *American Journal of Railway Appliances*. A series of experiments, which lasted over 12 months, was carried out with a view to ascertain the effects of contact with oils upon various metals.

The metals to be tested were first thoroughly cleaned with ether and then dried. The weights were then taken and the metals placed in closed tubes filled with the oils, and kept for 12 months at a mean temperature of 27° C. during the summer and 10° to 13° C. during the winter.

The following results were obtained :—

Iron.—Least attacked by seal oil, and most affected by tallow oil.

Bronze.—Is not attacked by colza oil. It is very little affected by olive oil, and very considerable action is produced by cotton-seed oil.

Lead.—Least acted upon by olive oil ; greatest action noticed with whale oil. Lard and spermaceti oils have almost the same effect as whale oil.

Zinc.—Seems to be but little attacked by mineral lubricating oils. The least action is noticed in the presence of lard oil, and the greatest with spermaceti oil.

Copper.—Is not attacked by mineral lubricating oils. It is least affected by spermaceti oil, and most attacked by tallow oil.

The results of the experiments show that mineral oils had the least effect upon the metals tested, and that the greatest action was produced by tallow oil.

The following table gives a *resumé* of the experiments :—

Oils.	Metals not attacked.	Metals least attacked.	Metals most attacked.
Mineral	Zinc and copper.	Bronze.	Lead.
Olive	...	Tin.	Copper.
Colza	Bronze and tin.	Iron.	Copper.
Tallow	...	Tin.	Copper.
Lard	...	Zinc.	Copper.
Cotton-seed ...	...	Lead.	Tin.
Spermaceti ...	...	Bronze.	Zinc.
Whale	Tin.	Bronze.	Lead.
Seal	...	Bronze.	Copper.

Iron might, I think, have been added to the list of metals most affected by tallow oil.

It is to be regretted that certain other oils were not included in the experiments, which would then have been of a very exhaustive nature.

W.

Primary Batteries.

A paper by Mr. Perry F. Nursey on "Primary batteries for illuminating purposes," read at the Society of Engineers on November 7th, was noticed in your last issue. On referring to a verbatim report of the paper, I find that, in describing the Lalande battery, Mr. Nursey said : "Although the battery is the invention of M. Lalande, the credit of attempting to utilise

the residual product from it is due to Mr. J. Berger Spence, head of the firm of manufacturing chemists bearing that name. And it came about in the following manner :—The manufacture of oxide of zinc is in ordinary a costly process, and Mr. Spence had for some time past been casting about for a more economical method. Amongst other things he tried electrical decomposition ; and whilst engaged in his experiments in that direction, he became acquainted with M. Lalande who he found had a battery which was giving exactly the result Mr. Spence wanted." According to another paragraph in Mr. Nursey's paper, this all took place in 1884.

Now, the Lalande battery is really only a modification of the one bearing my name, the difference being the use of oxide of copper in the iron cell instead of iron or steel borings, and the result of the difference being an increase of quantity and constancy and a decrease of electromotive force, the E.M.F of a Lalande being less than a volt, and that of a Bennett 1·38 volts. My battery was invented in 1881, and on February 1st, 1882, (the date of Lalande's patent being March 27th, 1882) I read a paper on the subject at the Glasgow Philosophical Society, in which special prominence was given to the recovery of zinc ozide from the exhausted solution, and the use of it in the arts ; and a bottle containing zinc oxide which had been, at my request, recovered from a worked-out cell by Dr. Smith, of the North British Chemical Works, Kilbowie, was handed round the audience. The exact words used by me were as follows :—". . . . but it becomes even cheaper when it is considered that the chief product of its action is zinc oxide, known in the paint trade as zinc white, which is extensively used as a pigment and as a substitute for white lead. It can easily be recovered in an approximately pure state from the used-up battery. From the cell which rang the bell for a month 1,458 grains were recovered, the zinc consumed being 1,170 grains. Some of it is on the table before you. Its price in the market ranges from 6d. to 1s. 6d. per lb., according to purity. As this is by no means a bad sample, containing only a slight trace of iron, its value exceeds that of the zinc consumed." Further on, referring to the uses to which a gentleman might put the battery, I said : ". . . . . and, after all, when the battery ceases to work he can take it to pieces and paint his house, or a part of it, with the products."

Besides being noticed in the Scotch journals, my paper was printed *in extenso* in several of the London periodicals, notably, in the ELECTRICAL REVIEW, February 18th, 1882 ; the *Electrician*, February 25th and March 4th, 1882 ; and in the *English Mechanic* about the same time, while copious extracts were given in others. It was likewise reprinted in America, and translations appeared in France, Germany, and Italy. All this took place early in 1882, yet in 1884 a company was formed in London to work the Lalande battery which put forward the recovery of zinc oxide as a novel and principal feature ; and in 1887 Mr. Nursey, while posing as an authority on voltaic batteries, gravely adopts the error !

A. R. Bennett.

November 15th, 1887.

Submarine Research.

The very able paper read by Mr. E. Stallibrass at the late meeting of the Society of Telegraph-Engineers and Electricians contains two or three statements which I think call for some remark. It certainly seems a pity that, considering the lateness of the hour at which the paper was concluded, the President did not adjourn the discussion until another evening. Those present must have been much interested in the paper itself, and the remarks made by Mr. J. Y. Buchanan were especially worthy of consideration, coming, as they did, from so experienced an observer. Now there were a good many members present who, from their long and intimate acquaintance with submarine telegraphy and consequently with sounding work, could certainly have given the meeting much matter of the greatest interest.

The first point is the doubt apparently implied as to the effects of sea bottoms upon the sheathing wires of cables. The author said, "the effect, if any ;" I hope I do not misquote him, but this was the impression conveyed. Without referring to manganese, oxides of iron, outcrops of copper, &c., which are of only very local and infrequent occurrence, I would point out that the sheathing wires of cables have been destroyed through chemical action when lying in a bed of sand and decomposed coral, a position one would expect to be perfectly secure. The chemical action referred to takes place in certain localities, long stretches of sound cable intervening between these patches. Under the same conditions as regards the outer protection of the sheathing wires and on apparently exactly the same kind of bottom, the sheathing wires in some places are destroyed frequently and rapidly, while the rest of the cable remains perfectly uninjured. The difficulty of course lies in the fact that the injurious and non-injurious bottoms are to all appearance composed alike. Here the analytical chemist is of service.

The second point which seems open to discussion is the opinion expressed by the author of the paper as to the most opportune moment of detaching the weight. He thinks that it is advisable to get the wire in an up and down position under the influence of some strain, the weight being detached on heaving up. I, for one, hold exactly the contrary opinion. Considering the tendency of the wire to run into coils and overlay itself through overrunning when the weight touches the bottom, the bringing a strain upon the wire before detaching the weight seems to me a premium upon drawing the slack wire into a kink ; the result being a detaching of more than bargained for. Whereas if the weight detaches immediately on striking bottom, there is little, if any, influence exerted in the direction of drawing the slack wire into a kink.

The dangers attending the fingering of the sounding wire pointed out by Mr. Buchanan, were surely misapprehended by Mr. Stallibrass and other gentlemen who thought that the rusting of the wire consequent upon handling was meant. I think the dangers suggested consisted of the possibility of a careless man while placing the wire round the "V" wheel for picking up, might injure the wire either by a sharp bend or put a kink in it, accidents which have certainly occurred. Hence Mr. Buchanan's remark, "I think it most important that the wire should be picked up in the same position as paid out," that is, I presume, paid out round the "V" wheel.

I cannot participate in Mr. Buchanan's declaration of faith in the reliability of pianoforte wire where valuable instruments are concerned. I have seen too many cases where the losses incurred through trusting too implicitly on the strength of the wire have proved of serious inconvenience. In taking aerial temperatures, for instance, when several thermometers may be attached at the same time, the use of light buoy rope weighted with an ordinary mushroom would appear to be the simplest and safest method. Of course so heavy a line is not necessary ; but as I refer more especially to observations made by cable ships, the fact of making the best use of the gear on board, though originally intended for other purposes, may save expense in extra appliances.

With reference to the Cassella thermometers, there is a point in connection with their use not touched upon at the meeting. These thermometers, useful as they were for rough work, owe any claim they may now have as scientific instruments to Mr. Buchanan, who has had the happy idea of marking a millimetre scale on the tube containing the mercury. Thus the errors due to the ordinary scale being separated from the mercury tube, and consequently liable to shifting, have been eliminated.

There are several other points well worthy of discussion, but I am afraid that my letter has already assumed undue proportions ; my excuse must be the great interest attached to the subject-matter of Mr. Stallibrass's paper.

X. X. X.